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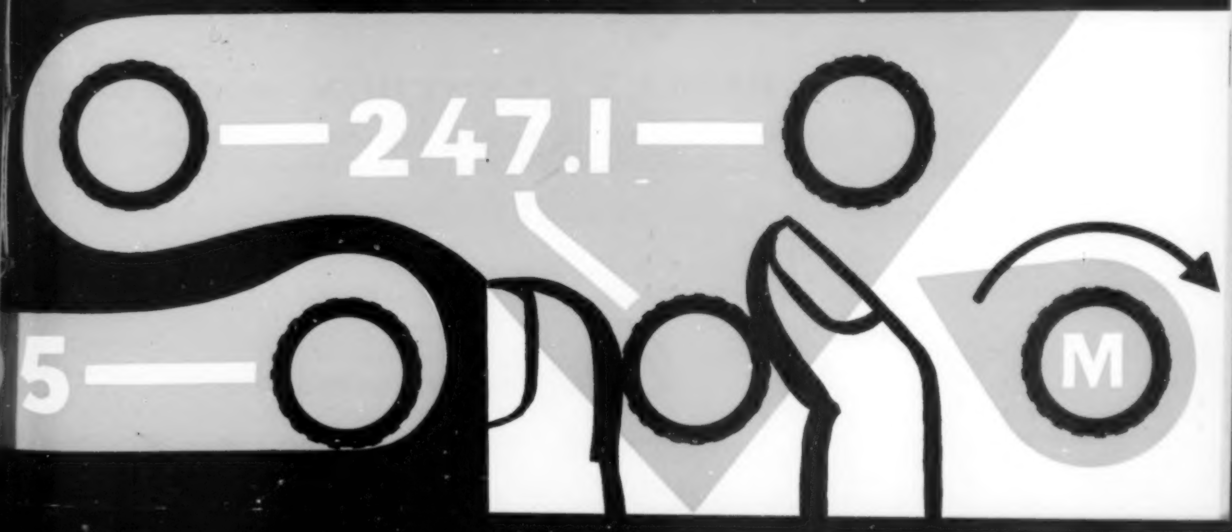


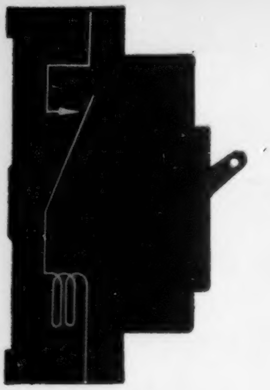
september 1957

volume one, number **5**

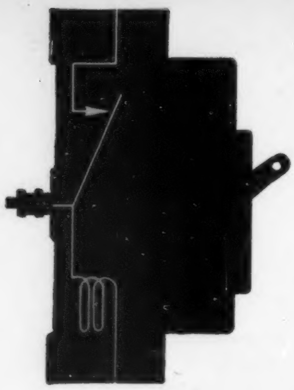
CANADIAN ELECTRONICS ENGINEERING

Departments

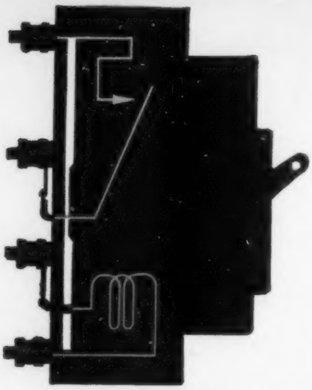
***our cover design** *The link between the human operator and the machine is the control panel, a theme symbolized here*



SERIES-TRIP
Over-current sensing and circuit interruption take place in the protected circuit. Breaker may also serve as the equipment power switch.

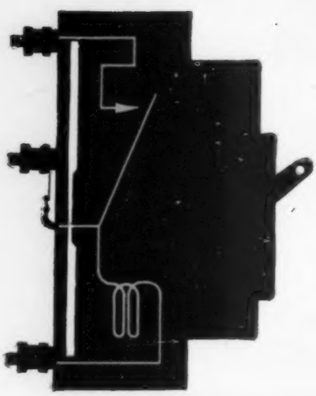


SHUNT-TRIP
Permits remote tripping through appropriate circuit-closing contacts in remote-control or safety devices.

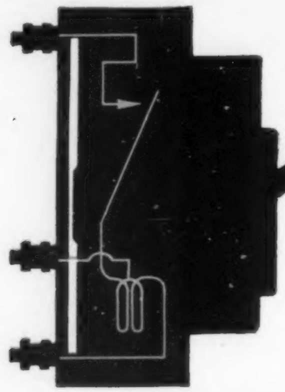


RELAY-TRIP
Provides a separate control circuit through the coil terminals; this circuit may be at a higher or lower voltage.

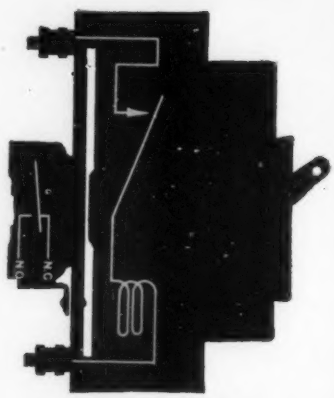
versatility...



CALIBRATING-TAP
Permits control of two circuits, with tripping in response to overloads in main circuit only.



DUAL-RATING
Protects equipment capable of operating on either of two input voltages. The breaker has two current ratings, one overload coil.



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contributors to this issue:

D. Gordon Auld (New amplification technique makes sound quite natural) can go back to the early days of TV. Shortly after he graduated from McGill in 1935 he worked in Montreal on a 60-line TV system which used a series of mirrors as a mechanical scanner. And the system actually went on the air, with the call VE9AK.

Mr. Auld comes from Regina, went to the University of Saskatchewan and graduated in electrical engineering at McGill. From 1935-37 he journeyed between the States and Canada and then joined TCA in 1937 at its inception.

During the war he had six years with the RCAF on radar and communications ending up as a Squadron Leader. During his assignment with Engineered Sound Systems Ltd., he has been on leave of absence from TCA.

One of the co-authors on the omegatron, **P. A. Redhead** comes from England where he took a B.A. at Cambridge in 1944. He worked with the British Admiralty from 1944-47 then joined the National Research Council staff. He is in charge of the Electron Physics Group of the Radio and Electrical Engineering Division.

L. R. McNarry comes from Foxwarren, Manitoba. He was in the RCAF as a radar officer during the war. He took a B.Sc. at the University of Western Ontario in 1949 and followed this with an M.Sc. from the same University in 1951. He joined NRC in 1950 and has worked in the Electronic Physics Group since then.

After three years in the U. S. Army Signal Corps during World War II **Ralph J. Meyer** (The new look electronic controls) went to the University cf Iowa from where he received his B.S.M.E. degree in 1950, then joined Collins Radio Company.

He has worked on the design of control units for numerous airborne communications equipment, design applications of the Collins autotune and high-speed autopositioner systems. He is currently assigned to the Mechanical Airborne Systems Group of Collins Research and Development Department II.

Meyer

Leaver

Before the word automation was thought of **Eric W. Leaver** (Industry needs a new approach to electronics) had written an article published in the States which he and fellow author Dr. J. J. Brown called "Machines without men."

Mr. Leaver, born in England, came to Canada 35 years ago. During the 1930s he worked on experimental television systems, 1939-41 was chief instructor at a radio school and from 1941 to 44 was with Research Enterprises Ltd. After a period with NRC he founded Electronic Associates Ltd. in 1946 with George R. Mounce.

He is a member of the APEO, IRE and CAP. Among other activities he is a director of RETMA.

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People in the industry

Commander is general manager of Edo in Canada

Vice-president and general manager of the recently established firm of Edo (Canada) Ltd. is Ralph R. Hind. The Canadian firm is a subsidiary of the Edo Corporation, College Point, N.Y., manufacturers of under-water acoustical equipment, electronic navigation devices and aircraft components.

Mr. Hind recently retired from the Royal Canadian Navy where, with the rank of commander, he was closely associated with the naval shipbuilding construction program. He is a native of Weyburn, Saskatchewan, and studied engineering at Rutherford College in England.

Edo (Canada) Ltd., is constructing a new plant on a ten-acre site at Cornwall, Ontario. It is expected to be ready in October and will specialize in the field of under-water acoustics, hydro-dynamic research and Edo floats for seaplanes.

General Manager of Federal Wire and Cable

Elmer J. Goetz has been named general manager, Federal Wire and Cable Division of the H. K. Porter Company (Canada) Ltd. Mr. Goetz received his education in Guelph and on graduating from high school joined the staff of Federal Wire and Cable. During his association with the firm he was assistant superintendent, superintendent and works manager.

Mr. Goetz is a past president of the Guelph Junior Board of Trade and an active member in the Knights of Columbus, Guelph Wing 400 RCAF, the Niagara District Electric Club and the Guelph Garrison Officers Mess.

New appointment at Canadian Applied Research

Eric B. Moss, 55, has been appointed Director of Engineering of the newly-named Canadian Applied Research Ltd., of Toronto, Ontario. Since 1953 Mr. Moss has been technical director of Smiths Aircraft Instruments Ltd., England, where he supervised the activities of 350 engineers and technicians working on such complex systems as the S.E.P.2 autopilot, the Smith Flight System, Tacan Indicator and Coupling Unit and the latest jet engine controls.

In 1951 Mr. Smith was appointed a director of K.L.G. Sparking Plugs Ltd. and in 1952 took on the technical directorship of Waymouth Gauges and Instruments Ltd. He is a Fellow of the Institute of Physics and the Royal Aeronautical Society and is also a member of the Institution of Mechanical Engineers.

New company based in Waterloo

Electronic Craftsmen Ltd., has acquired the assets of Electro Coil Co., Waterloo, a firm formed seven years ago to specialize in the manufacture of automotive ignition coils. Electronic Craftsmen will manufacture spring coils for television tuners, automotive coils, epoxy molded coils for electronic relay, solenoid and geophysical applications.

President for the company is Hugh T. Watt and vice-president is John G. Varga who is also general manager. Mr. Watt founded Watt Electronic Products Ltd., five years ago. Mr. Varga was founder and major partner of Electro Coil Co.

Kingan

Houlding

Two vice-presidents at RCA Victor

RCA Victor have appointed as vice-presidents John J. Kingan, assistant to the president, and J. D. Houlding, technical products.

Mr. Kingan, previously general manager of Canadian Marconi, was born in England. He served with the Royal Canadian Corps of Signals as a Lt.-Colonel and later with the RCN as a Commander.

Mr. Houlding graduated from the University of Western Ontario. Previously he was with Canadian Westinghouse and held the positions of manager, electronics, industrial products and atomic energy division.

Cowan

May

Best

Beattie

Executives at Daystrom

Executives of Daystrom Ltd., whose headquarters are in Toronto, include H. W. Cowan as manager and Otto E. May, Jr. as comptroller. Manager of the Montreal branch is D. R. Best, P.Eng., and D. R. Beattie, M.E.I.C., P.Eng., is responsible for Toronto sales.

The company has 10,000 feet of floor space at 840 Caledonia Road, Toronto. Immediate activities will cover sales and services but it is intended to set up manufacturing facilities.

Daystrom products include: electrical measuring instruments for industry, utilities and transportation; navigation systems for commercial and military aircraft, hi-fidelity audio equipment for the home and analog computers for industry and research.

Appointments, news in brief

Among the promotions announced at the University of Toronto by President Sidney Smith are the following: to the rank of professor, B. Etkin (aerophysics); to associate professor, H. S. Ribner (aerophysics); to assistant professor, P. P. Biringer (electrical engineering).

P. W. Oliver, P.Eng., formerly director of collective relations, is now Director of Employee Relations in the Hydro-Electric Power Commission of Ontario. Mr. Oliver, a native of Dorchester, Ont., has been with the Commission since 1925.

John Woods, of North York, Toronto, a vice-president of Canadian Admiral Sales Ltd., died in a drowning accident in the Haliburton region. A native of London, England, he came to Canada ten years ago.


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Honeywell's big contract for CF-100 control system

Big contracts have gone to Honeywell Controls Ltd., Toronto and Minneapolis-Honeywell Regulator Company, Minneapolis, Minnesota, for automatic control systems on the Avro CF-100 jet fighter plane. Plans for the modification of the CF-100s to carry the equipment were announced by Carl Anderson, vice-president of the aeronautical division of Honeywell Controls Ltd.

"With the addition of Honeywell's fire control coupler system" said Mr. Anderson "the CF-100s will be able to guide themselves by radar contact on an intercepting path toward a target and then start firing at the target, all automatically."

Included in the CF-100 modification program is a contract from the RCAF for a "command signal limiting system" and a contract being handled through the U. S. air force for components of the automatic fire control coupler system.

Preliminary design work and manufacture of some CF-100 control piece parts were done at the aeronautical division plant in Minneapolis. Accelerometers for the command signal limiting equipment were manufactured by the corporation's Boston division. The bulk of the design and assembly is being conducted at the Honeywell plant in Toronto.

Closed TV circuit at paper mill

Two cameras have been installed at the Dryden Paper Company's mill, near Dryden, Ont., and with a closed television circuit have brought an inaccessible area into view on monitor screens about 1,000 ft. away.

The cameras are located one at the top of a chip storage bin and the second at the chip removal system at the bottom. The bin has sufficient capacity to carry the digestors for several hours and allows the chip supply equipment to be shut down for repairs and maintenance without production loss. In order to schedule chip production and allow for maintenance the capacity of the bin must be closely watched.

The two cameras were sold and installed by Canadian Westinghouse.

Ferranti's new access equipment

Ferranti Electric Limited have developed for TCA a highly versatile new access equipment. In its initial use it will provide a demonstration reservation system.

The desk type unit, known as the Ferranti Transactor, provides combined input and output facilities in electronic digital data processing systems.

The transactor reads pencil marked cards statically and records output with punch marks on the input card. A complete input and output record of each transaction is kept on the input card. The static reading process permits flexibility in card layout.

Canada Wire build at Vancouver

Canada Wire and Cable Company Ltd., will have a new plant on a 15-acre site on Annacis Industrial Estate, adjacent to Vancouver.

President O. W. Titus says: "To keep pace with the increasing industrial activity in British Columbia the new plant will immediately provide double the present manufacturing area of the plant we have operated on Powell St. in Vancouver since 1949."

"We expect that the plant will require approximately twice the number of men presently employed. The warehouse and sales office of the company wlll remain at the same location, 1494 Powell St."

Audio, TV circuits in Montreal hotel

The Queen Elizabeth, CNR's new hotel due to open in Montreal in the spring of next year, will have radio, television and recorded music in every room. It will be possible to select and distribute programs on six of nine possible television channels and on six of ten possible radio and audio circuits.

Among the special features are facilities for distributing closed circuit telecasts—particularly useful for conventions—and an emergency signal system for every room.

The entire communications network is being installed by the RCA Victor Company of Canada.

New five-inch Charactron (right) is much smaller than the older tube.

New tube comes down in size

A charactron shaped beam tube has been developed which is small enough for aircraft use and yet able to reproduce a conventional radar display map and then print labels on it. The tube, developed by Stromberg-Carlson and shown above (right), is five inches in diameter and 17½ inches long compared with the older tube (left), seven inches in diameter and 40 inches long.

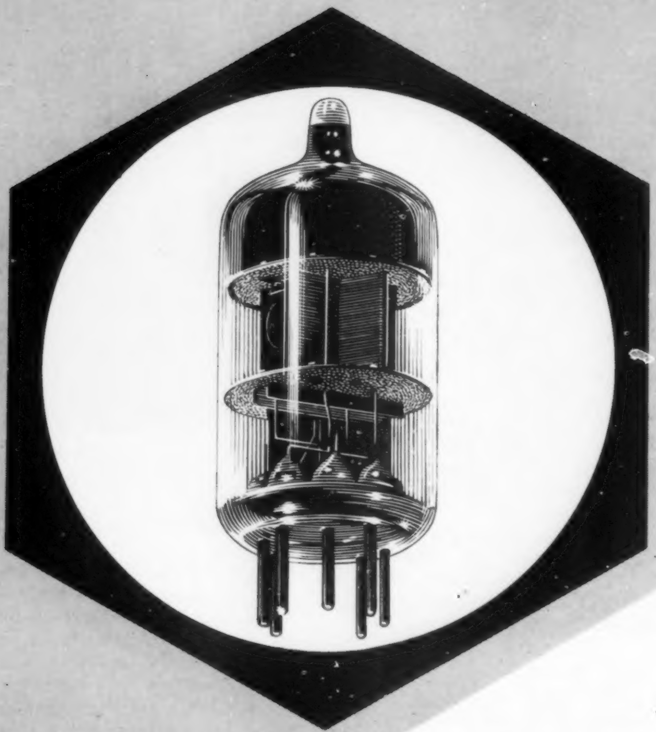
The tube accomplishes the dual function of a radar tube and a tube displaying characters by means of time sharing — the characters are printed on the phosphor screen at the rate of 20,000 a second and retained by the phosphor while the electronic device does its radar work in between letters and numbers.

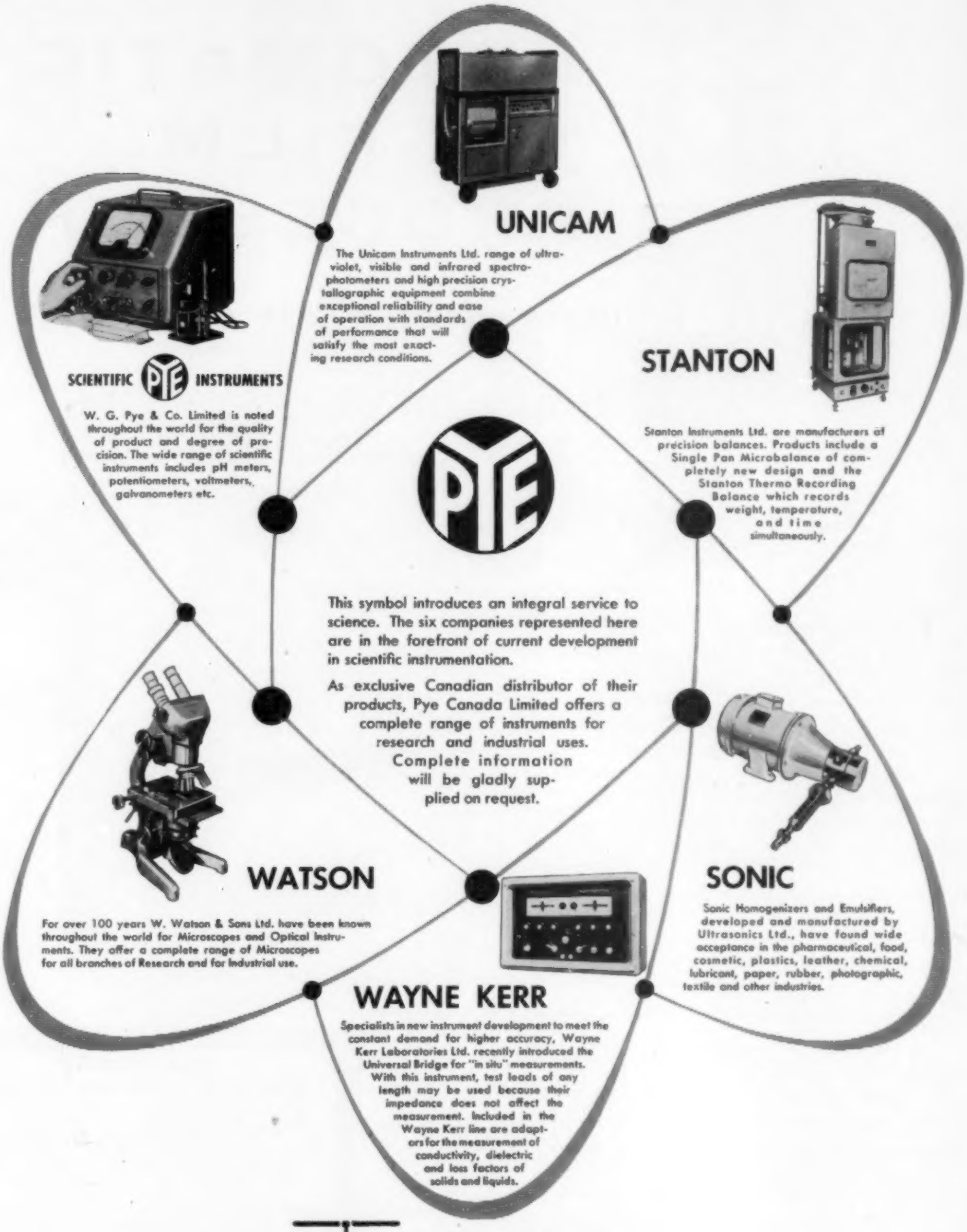
Among other uses the tube can condense flight data for a pilot or display navigational information from an airborne computer by reproducing moving maps and symbols in a form which the pilot can read and understand quickly.

News in brief

Canadian Westinghouse, Hamilton, Ont., say the new 110-degree television picture tube has been in production for several months and by the end of 1957 the company expects to be able to run all production facilities on the tube.

F. D. Bolton Ltd., 926 East Hastings St., Vancouver 4, B.C., have been appointed sales representatives for the Western Provinces by Heinemann Electric Company, Trenton, N.J.





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CANADIAN
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Industry must help in technician training

The recent approval by the Executive Committee of the Institute of Radio Engineers of two new Professional Groups should be of considerable interest to all ranks in the electronics industry. The new groups, on Engineering Writing and Speech and on Education, should be able to make valuable contributions within the electronic engineering profession.

Thousands of words could be written on the value of establishing a facility for the exchange of information and ideas on the improvement of written and verbal communication in the face of the ever-increasing complexity of electronic devices and equipment. The significant increase in the technical publications activities of many companies also adds importance to the study of such matters. Certainly we welcome the formation of the PGEWS, and look forward to hearing of its activities.

Many authorities—and others—have been eloquent on the problems of providing an adequate engineering education to a sufficient number of students to meet the constantly growing demands of the industry. Opinions have been widely expressed on the extent to which engineering degree courses should be specialized. The problem of attracting high-school graduates to engineering courses in the face of the competition of other faculties has also been of great concern.

We would like, however, to use this occasion to focus attention on a related problem—that of providing sufficient facilities for the training of technicians capable of taking much of the load of routine work off the shoulders of the professional engineer.

The recent move by the Association of Professional Engineers of Ontario in establishing a program of certification for engineering technicians should provide an incentive to the technicians themselves and to others who are thinking of taking up this type of work. But the principal need appears to be the provision of more technical institutes such as Ryerson in Toronto, and this will probably require the sponsorship of both government and industry. At least one company in the electronics field has made a move in the right direction by initiating an apprenticeship scheme for laboratory and model shop technicians and supporting appropriate spare time technical courses at schools in the locality.

We invite our readers in government, industry and education to use our pages to express their opinions in this matter.

A change of name

With this issue our name has been changed slightly, from Electronics Engineering of Canada to Canadian Electronics Engineering. This associates us more closely with the industry we serve, but does not mean any other change in policy. We shall continue to maintain the high technical level in editorial presentation, set in our previous issues.

THE EDITOR

Captain and First Officer of Vickers "Viscount" airliner face complex array of aircraft and navigation controls

Application of human engineering leads to

The new look electronic controls

RALPH J. MEYER, B.S.M.E.*

During World War II many new machines and techniques were developed which imposed new demands upon the men who were involved. Many times the full capacity of these man-operated machines was not realized because of the limitations of the human operators. Design emphasis of various equipment has been placed on improvement of the machine itself, with little attention given to the human operators. Lack of readily available information on how to improve design in terms of human capabilities and limitations stimulated little or no interest.

*Collins Radio Company, Cedar Rapids, Iowa

Basic information concerning the human operator had to come from those sciences which study the human directly: psychology, anthropology, sociology, anatomy and physiology. The field of psychology pioneered studies to obtain this information. The experimental psychologist has the necessary experience and fundamental training to interpret pertinent scientific data in terms of appropriate design recommendations. He also has training in the specialized experimental techniques which could be used to solve specific problems. From this activity, the new field of "human engineering" has emerged. This new field does not replace any existing design function but merely extends the range

of design possibilities. The field of human engineering is not limited to any one particular field of learning. Many human engineering groups or divisions currently are staffed by psychologists, mathematicians, engineers and physicists who work together as a team in the solution of design problems.

The average engineer finds it difficult to keep abreast of the field. Because of the number and complexity of the sciences involved, he can only use existing design guides and recommended practices. Research and basic studies require a broad background to successfully interpret results for practical application.

In addition to the many complexities associated with the actual flight control of the aircraft are the problems of electronic equipment. Radio communications systems, navigation aids, and radar have rapidly become so complex that human operators are sometimes no longer able to realize the full potential of these systems. Many months of extensive training are often required for the ordinary man to learn to operate this equipment. To understand properly some of the problems involved, one has only to get a pilot's-eye view of the interior of a modern jet aircraft. This bewildering complex of instruments, controls, displays and other equipment leaves little doubt that the engineering psychologist has some challenging display and control problems. Most present-day electronic controls are not designed for effective use in high-performance aircraft.

In applying human engineering principles to the design of electronic controls, the prime objectives are as follows:

(1) Improved efficiency in the use and operation of controls.
(2) Greater flight safety through reduction of possible pilot errors.
(3) Improved operation comfort.

To accomplish these objectives a considerable number of new approaches and design concepts had to be applied. Some of the more important design criteria will now be discussed.

Frequency and channel displays

To the human operator the most important information displayed on a communications control unit is the frequency and/or channel information. Many other types of displays and controls (such as volume, emission selector, etc.) are presented and are necessary for complete operation of the particular equipment, but the majority are of secondary importance. For this reason, it is essential that all frequency and/or channel information displays and controls be given prime consideration.

The complexity of the modern airplane has imposed an exacting and difficult task upon its pilot. Application of human engineering principles to the design of electronic controls has simplified this task. Important factors considered are: the use of digital type displays with large simply-designed horizontal characters; choice of the best location, shape and type of movement of each control knob; and the integration of several control panels.

Recent human engineering studies have indicated the desirability of a counter-type visual display for precise numerical values such as frequency or channel information. One of the most important objectives in designing or selecting a counter is to provide a device which is easy to read. The design of numerals should be without extra flourishes which tend to be confusing. Figure details should be simple but prominent. Numeral height should be in the range of 3/16 inch to ¼ inch. This height is based on an average viewing distance of 18 to 30 inches.

Counter wheels, regardless of the method of actuation should normally "snap" into a positive position. The presence of "bounce" or blurring tends to reduce the over-all effectiveness of the display. It reduces the efficiency of the operator considerably and the reading time is increased. Also the ability to read the number correctly is reduced and as a result the hoped-for improvement in readability has been offset by poor detail design. Another important consideration is counter orientation. Counters should be oriented so that they may be read from left to right. Vertical orientation should be avoided.

Control location

First priority as to location on the panel should be given to control or displays that are to be used most frequently, or most effectively. Controls should be located close to their corresponding display. The final location should be such that it permits efficient selection and manipulation. Choosing a location which is subject to accidental operation of the control or possible injury to operating personnel should be avoided. Other factors which will influence the final choice will be reading distance, viewing angle, illumination, presence of other controls and location and type of adjacent controls.

Another important consideration is the arrangement of a pattern of controls. Perhaps more important than the frequency of use of controls is the sequence of use of controls. After the operator has used a certain control, which one does he use next? Sometimes, it is essential that two controls be used in sequence, whether or not they are used very often, and this must be considered in the arrangement of controls. If the task is very complicated and if there are very many controls, this is a difficult problem, but there is a general answer and principle. Controls having a similar function should be grouped together. A control that is frequently used immediately after another control should be placed next to or very close to it.

As an aid in the layout of electronic controls it is sometimes advisable to study actual pilot activity during takeoff, in flight, and in landing operations. A study of this type is desirable because it focuses attention upon the fact that the pilot has to be concerned not only with his electronic controls but also with many other complex equipments and operation. Available time to perform a certain function, be it control operation or otherwise, is very limited in high performance aircraft.

In most designs a compromise is usually made, as it is impractical to satisfy ideal conditions. To aid the final choice materially, it is advisable to construct a mock-up. This mock-up need not be elaborate, but should be accurately scaled. Cardboard or wooden mock-ups of control-panel layouts have proved very useful. With this additional design tool available, it is possible to find and solve many problems of control and display location at an early stage of development, thus ensuring that the best possible design features have been incorporated before construction of the final model.

Control operation

We have known for a long time that many aircraft accidents were ascribed to "pilot errors," not to failure of the airplane. Possible pilot errors made in operating electronic controls may be of the following type: confusion errors, crowding of controls, adjustment errors, reversal errors, and unintentional errors. There are undoubtedly many other types but these are the most significant which can be remedied by engineering design.

To make electronic controls and displays less confusing it would be desirable to have a standard location of the complete panel. This is mainly a problem with the airframe and cockpit designers and the implementation of this program will not be discussed further. To look at a design of several different aircraft would make it clear why this type of error frequently happens. It is no wonder that a pilot makes mistakes when he finds, for instance, the same uhf communication control in a different location in every aircraft he flies.

Further improvements can be made on the actual control panel itself. Future applications indicate the desirability of a standard control panel. As an example, let us suppose that all uhf communiciation frequency controls would be located on the top portion of the particular UHF COMM panel. Thus, any pilot flying any aircraft would know exactly where these controls would be located. Considerable research and study must be done to accomplish this program but its results would have a tremendous effect on the increased efficiency of the electronic control operation. To further minimize confusion, all controls and displays should be clearly and legibly marked with standard nomenclature. Panel layout should be as simple as possible, eliminating any unnecessary controls and combining functions where possible.

Another source of trouble in control operation is crowding of controls. This results in so-called pilot errors of unintentional operation. When controls are too close together, it is difficult and sometimes impossible to operate one control without accidentally moving another one. Certainly these are engineering faults and are many times unjustly blamed on pilots. Very little information is available on knob spacing; however, the environmental conditions of the particular application should be of prime consideration.

To avoid control operation and reduce errors it is possible to make controls more distinguishable by coding. This may be accomplished by four general methods: color, size, shape, and position. Color coding may be used to establish relationship from one equipment to another. Since all colors are variously affected by lower light levels, it is very important to select colors that are readily recognized under the expected illumination conditions. Some research has been done on this problem but little use has been made of color coding of electronic controls. At the present time there are no standard rules for coding controls by size. This method can be used with some degree of success but only in terms of relative size. Shape coding has been used somewhat but the question is still how many and what kind are distinguishable.

Another question which faces the engineering psychologist is the amount of effort the operator is required to exert to operate the control. In general, there are three different values of control forces that we are interested in. First is the maximum control force, which is the greatest force that an operator can exert under any and all conditions of control usage. At the other extreme is the minimum control force, somewhere in between the maximum and minimum forces, which gives the best performance.

Several things limit the minimum control force. For instance, every control has friction. We can often reduce the friction considerably but can never eliminate it entirely. Another important limitation is the "feel." The matter of "feel" is always important to the pilot for it enables him to judge how much movement he has made. Low friction components —such as volume potentiometers often require the addition of more control force to give the control a "good feel," and also to prevent movement during vibration.

The problem of maximum control forces that must be overcome is limited by the greatest force that can be exerted by the weakest person likely to operate the control. Actually we are not concerned with the maximum force because the human operators should not be expected to perform at maximum capacity for extended periods of time.

For most controls there is some optimum control force. This force enables the operator to have a "good feel" yet does not require exertion of a force which would bring early exhaustion or fatigue. For most detented electronic controls a torque of 1 to 1½ pound inches is recommended. Detent action should be sharp and crisp. Sluggish or double-detenting should be avoided.

Pressure suit factors

Long distance, hypersonic flights are tomorrow's military necessity, and the field of aviation medicine must keep pace with speed engineers and keep the weakest link in the chain—the human being—fully protected so that he can stay alive to perform his duties of guidance and judgment. Recent developments in pilot personal gear have resulted in an improved full pressure suit. One can say that the pressure suit is only a garment used during an emergency to descend from extreme altitudes to nonpressurized breathing altitudes. However, in an actual military situation, a pilot encountering a need for his pressure suit also must have control of the airplane and still maintain a combat unit. With this in mind we come to the conclusion that many electronic controls must be operational under conditions in which the pressure suit is inflated.

Recent improvements in pressure gear are greatly increasing the pilot's mobility. Restrictions on movement have been reduced considerably and the use of the ventilated garment has improved his comfort. However, we still have the ballooning effect which tends to give a bulky appearance.

In addition to the previously discussed design principles, other factors to be considered when designing electronic controls for pressure suit operations are as follows:

(1) Limited use of multirevolution controls.
(2) Consideration of lever type controls to improve ease of operation and to reduce operator fatigue.
(3) Use of remote displays for frequency and channel information.

Very little information is available on control operation when wearing a pressure suit and considerable research must be done if we are to make electronic controls that are compatible with our high performance aircraft.

Illumination

Good illumination is necessary for electronic controls and should maintain the eye at an optimum dark-adaptation level and yet permit adequate visibility of instrument markings on a panel. For instance, the pilot must scan the night sky for dimly lighted objects such as other aircraft or landmarks and must read his flight instruments and control panels. To obtain the optimum level of dark-adaptation with even the minimum amount of instrument light is very difficult but a satisfactory compromise can be made utilizing a minimum amount of "red light" of the proper wavelength. Most electronic control panels employ red lighting in conjunction with edge-lighting techniques. This type of display serves for daytime use (markings appear white on a black background) as well as for nighttime use (markings appear red on a black background) when used with red lighting.

Several of the important factors to be considered in designing control panel lighting are as follows:

(1) Suitable brightness levels.
(2) Uniformity in lighting.
(3) Minimum glare from either the light source or control panel.
(4) Suitable contrast with background.

Design applications

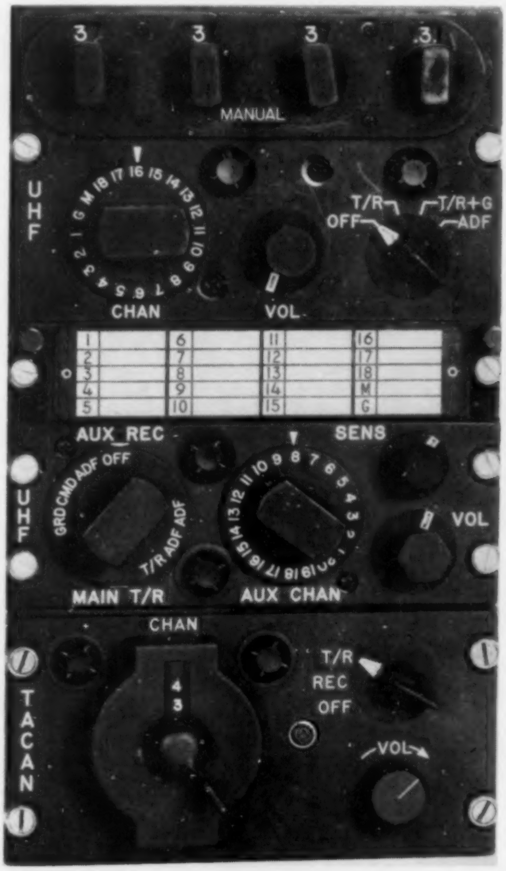
We now have the necessary background information as to the origin of human engineering and its relationship to electronic controls. Some of the basic human engineering principles and design concepts have been presented and discussed. The application of these principles to the design of electronic controls has resulted in "The New Look" which will be presented in the following examples:

Figure 1 shows a recent control unit for a commercial Automatic Direction Finder System. Emphasis has been placed on frequency presentation and the unit incorporates horizontal digital counter type presentation. All frequency numbers are easily read and ¼ inch in height. Control location has been selected according to operational requirements. Knob spacing is consistent according to operational requirements. Knob spacing is consistent with control operation and all controls incorporate positive detent action with low torque requirements. All frequency controls have round knobs of the same size to code controls by shape and size. The unit is also edge-lighted for adaptation to night flying.

With the recent introduction and wide acceptance of the weapons systems concept it is very often advisable to integrate several electronic control panels into a single unit. Figure 2 shows three separate controls of conventional design for use in a communication-navigation group installation. All frequency and channel numbers are ⅛ inch in height on all controls. The manual frequency dials are spaced rather far apart making reading somewhat difficult.

Fig. 1. Recent design of control unit for ADF system

Provision is available on the front panel for changing preset channels for the communications control. Sensitivity and volume knobs are spaced rather closely so that accidental operation of one control when operating the other is possible. The navigation control employs concentric knobs and a vertical display to present channel information. All units employ edge-lighting for night flying.



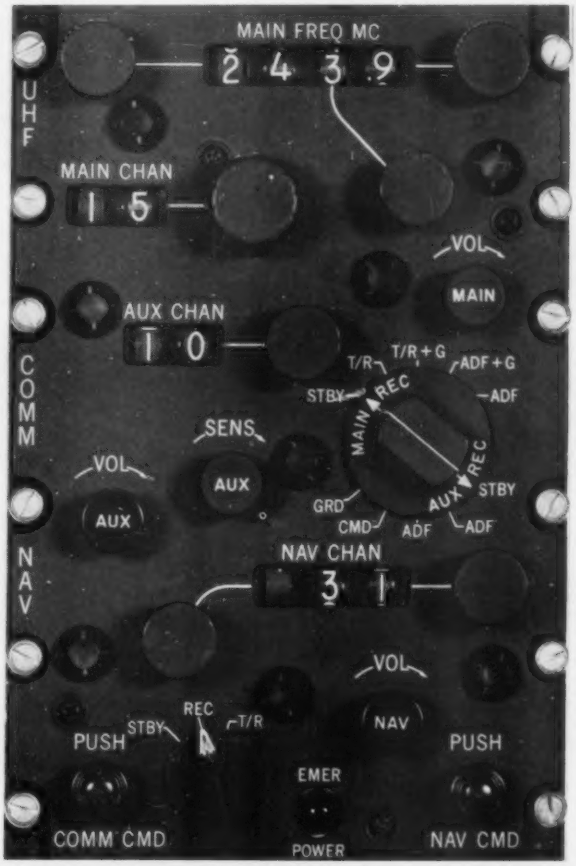


Fig. 2 (left). Three separate panels of conventional design in a communication-navigation group installation
Fig. 3 (right). Integrated panel shows results of applying human engineering principles to panels shown in Fig. 2

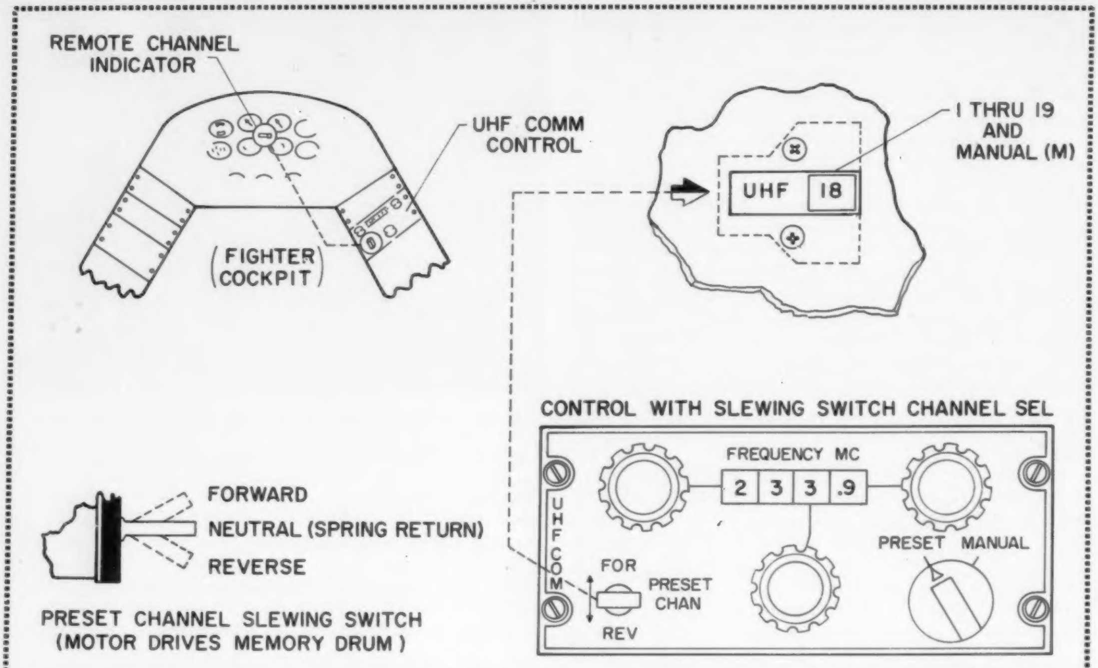


Fig. 4. Slewing switch type control and remote indicator improve preset channel operation of UHF COMM set

The results of integration and application of human engineering principles are illustrated in figure 3. All channel and frequency information is presented on horizontal digital type counters. Necessary eye movement to read manual frequency has been reduced considerably. The panel has been generally sectionalized by functional requirements. Provisions for changing preset channels has been removed from the front panel because this is not normally a function required in flight. All frequency and channel knobs are round and the same size except for the main channel knob. This knob has a larger diameter and deeper serrations to further aid shape and size coding. The communications function selector switches have been simplified and combined into one single switch. Channel displays have been simplified so that only operating channels used are displayed. All function selector controls have a bar or wing type knob which codes the control by shape. In addition the unit has master command controls for installations requiring dual controls. These controls are of the push button type to provide further means of identification. All controls incorporate low torque and positive detent action to ensure operation under severe environmental conditions. Other important advantages are reduction in required panel area and total weight over combined totals of individual units.

As we pass through an interim period in electronic control design some of the requirements for the future are self-evident. Many improvements over existing designs can be and must be made if our piloted aircraft of tomorrow is expected to perform its intended mission successfully.

As an example, let us consider what can be done to improve a typical uhf communications control. During flight when the pilot is occupied with the great complexities of a modern jet aircraft his primary usage of his UHF COMM concerns preset channel operation. Manual tuning is infrequently used and is therefore of secondary importance. To provide an improved present channel display we can utilize a remote channel indicator as shown in figure 4. Briefly, this system consists of a basic control unit having a slewing switch which controls a reversible motor. This motor, in turn, drives and positions (through suitable mechanisms) the present channel memory device and also a synchro which is built into the remote display instrument. This remote indicator may be placed at a strategic location on the instrument panel thus giving the pilot an ideal visual display. Channel numbers may be simple, large, and easily read with minimum chance for error. Operating time is also reduced, thus freeing the pilot for other activity. The use of a slewing switch to drive positioning mechanisms increases operator efficiency as it is no longer necessary to hand crank a control. The use of a lever type switch also reduces operator fatigue considerably, especially under conditions in which a pressure suit is used.

This is but one example of the many improvements which can be accomplished through application of human engineering design principles.

Conclusions

The design of electronic controls must of necessity be the result of a compromise among the many factors involved. Circuitry, controls, displays, and the human operator all are an integral part of the whole system. There is no simple solution to the complexities of control design, particularly because of conflicting priorities. The designer should try to imagine himself in the operator's position and visualize the task he must perform, the need for precision, the effect of errors, the problems associated with vision and visual acuity, and the interrelation of control operations. In all decisions the needs and duties of the human operator should be of prime consideration. Application of these principles will undoubtedly open many new approaches and improvements in electronic controls and displays.

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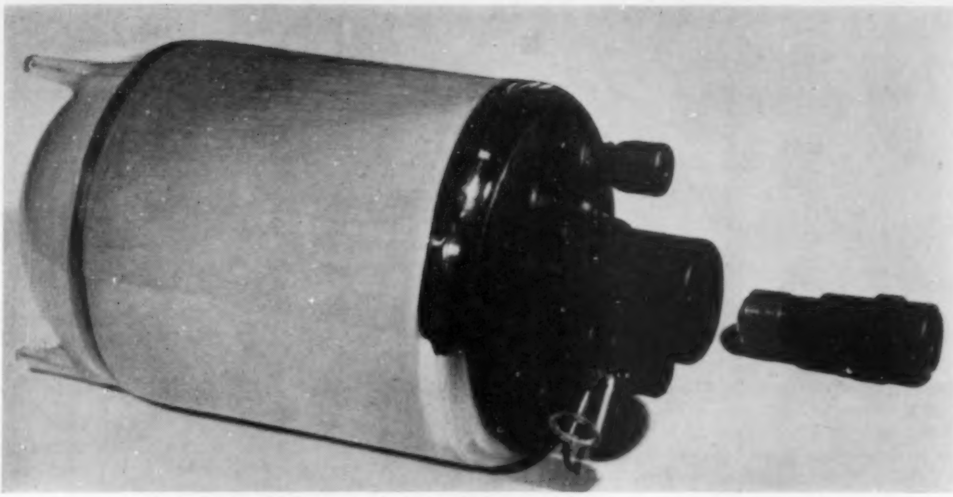


The image intensifier, an amplifier of energy in the radiant state

Image intensifiers give safe x-ray viewing in daylight

E. BATLER, B. SC. *

The image intensifier was the heart of the "snooperscope" which enabled World War II snipers and tank drivers to see in the dark. The same tube is now being used as a light amplifier which permits daylight viewing of an X-ray fluoroscope without increasing the X-ray intensity. Details are given of the operation of the image intensifier and of other possible applications.

The "Snooperscope," one of the more novel electronic devices of World War II, made it possible for the sniper to see in the dark. To aim at a target at night he looked into the eyepiece of a small device mounted on his rifle in a fashion similar to a telescopic sight. His target was displayed as a faint green silhouette against a background of cross-hairs. The green silhouette was an infra-red image of the target electronically amplified and converted into a visible image. Generally, an infra-red source was used to illuminate the landscape. By carefully filtering the visible light, the source was virtually invisible. This allowed the sniper to scan the landscape looking for suitable targets without risk of detection. Another use of the same instrument permitted tank drivers to drive at high speed over rough terrain without using visible light. Here again, an infra-red source was used to illuminate the path ahead of the tank.

The heart of these night-seeing devices is the "snooperscope" or "sniperscope" tube. This tube, called an image intensifier, is in effect an amplifier of energy in the radiant state.

A familiar principle of quantum physics is expressed by the formula relating the energy of light photons or quanta to their frequency: $e=hf$, where e is the energy of the photon, h is Plank's constant and f is the frequency. Since the frequency of infra-red radiation is less than that of visible light, so is the energy of each quanta. As a consequence, it is impossible to create a device that will convert an infra-red image directly into a visible image unless additional energy is introduced into the system to compensate for the difference in energy between an infra-red and visible quanta. In the image intensifier tube this is accomplished by optically focusing the infra-red image on a photo-cathode. The photo-cathode emits electrons to form an electron image whose density corresponds to the detail of the infra-red image. Energy is imparted to the emitted electrons by a high voltage accelerating source. Upon striking a fluorescent screen some distance away from the cathode (with an energy greater than that of emission) a visible image is created.

A novel extension of the snooperscope tube is now being sold commercially as an amplifier of extremely low intensity visible light images. The principles employed are very similar except that the amplified image originates from a virtually invisible light image. After a 1,000-fold intensification, the image produced is visible under ordinary light conditions.

Currently, the most important use of the image intensifier, as the light amplifier is commercially known, is in the fields of medical and industrial X-ray radiography.

Two methods of obtaining an image from X-rays are employed in medical and industrial radiography: film and fluoroscopy. When film is used, the patient is placed between an X-ray source and a piece of film. The X-rays penetrate the patient's body and are selectively absorbed: i.e. bone absorbs more than soft tissue. The exit X-rays strike the film creating a shadow-graph negative. The main disadvantage of this technique is the delay between exposure and viewing. Even under the best circumstances, several minutes are required for developing and fixing the

*Philips Industries Ltd., Toronto

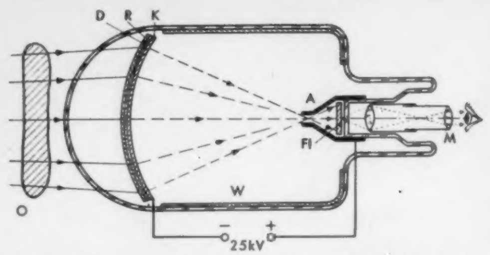


Fig. 1. Diagrammatic cross-section of the Image Intensifier. R=fluoroscopic screen on which the X-rays are received after passing through the object to be examined O, and the glass wall of the tube. D = support of fluoroscopic screen and photocathode K. The fluorescent radiations produced in R release electrons from the photocathode K. The "electronic image" is reproduced on a reduced scale by the electric field between K and the perforated anode A, on a viewing screen Fl; this image is observed through a simple microscope M. W is a conductive layer on the inside of the tube.

film. During an operation or emergency, several minutes can be extremely critical.

The second technique (fluoroscopy) substitutes a fluorescent screen for the piece of film. The X-ray shadow-graph is created by the fluorescent action of this special screen which emits light when it is struck by X-rays. But the big shortcoming of fluoroscopy is that it produces images of extremely low light intensity. As a result, viewing must take place in dark rooms and the observer must have dark-adapted eyes. When the observer's eyes are dark-adapted, the retinal cells known as rods are brought into play. Unfortunately, the rods or night vision cells can not discern detail as fine as the retinal cone cells. This means that the observer does not perceive some of the fine detail which may be present in the image. Of course, the image brightness can be increased by increasing the X-ray intensity passing through the patient. But this is dangerous for both the patient and the radiologist. The fact that X-ray dosages must be kept to as low a level as possible makes the use of fluoroscopy in an operating room very difficult. At the light levels required for surgery, fluoroscopy is not practical and vice versa. Rapid switching from high light levels to low levels is not feasible because it takes several minutes for the eye to adapt. As a consequence, the surgeon must depend on a radiologist wearing special glasses for his information.

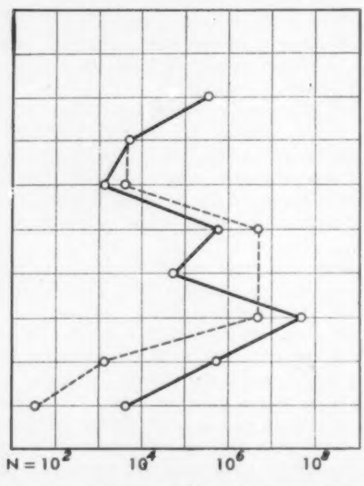
The image intensifier solves this problem. At present, it is possible to obtain a light gain in excess of 1,000 with a detail resolution superior to that of conventional fluorography.

Figure 1 shows the Philips image intensifier in cross-section. An X-ray beam passes through the object and through the glass wall of the cylindrical evacuated tube and reaches the fluorescent screen, which is mounted in one end of the tube. The fluorescent screen transforms the received X-radiation into a conventional fluoroscopic image. The light of this image frees electrons out of the sensitive photocathode, which is in close contact with the fluorescent screen. At each point of the photocathode, the number of freed electrons per second is proportional to the brightness of the fluorescent screen at that point and to the X-ray intensity.

In this way the latent X-ray image with all its variations in intensity is converted into an electron image with corresponding variations in electron density.

The electrons freed from the photocathode are accelerated by a high voltage from an external power source, applied between the photocathode and the open anode positioned at the far end of the tube. The electron image is electrostatically focused on a second fluorescent screen: the viewing screen.

This screen converts the energy of the impinging electrons into visible light. As is already indicated in the figure, the obtained image is far smaller than that of the fluorescent screen; (the image on the X-ray screen is 9 times that on the viewing screen). The brightness of this image, however, is much greater. First of all, the electrons emitted by the photocathode have been accelerated by the applied high voltage, which gives them a higher velocity. The higher the velocity of an electron when impinging on the viewing screen, the more visible light it will yield. Secondly, an electron-optical reduction of approximately nine times is introduced. In terms of areas this means that the electrons are concentrated on an 80



Stage of image transmission	Particles	N without I.I.	N with I.I.
On object	X-ray quanta	2.5×10^5	2.5×10^5
Transmitted by object	"	5×10^3	5×10^3
Absorbed by fluorescent screen	"	4×10^3	1.2×10^3
Emitted by fluorescent screen	Light quanta	4.5×10^6	6×10^5
Emitted by photocathode . .	Electrons		6×10^4
Emitted by viewing screen. .	Light quanta		6×10^7
In eye pupil	"	1.2×10^3	4×10^5
Absorbed by retina	"	3×10^1	4×10^3

Fig. 2. Average number of quanta or particles (N), for a round detail 2 mm in diameter, effective for 0.2 sec, in different image-stages in fluoroscopy without the image intensifier (dotted line) and with it (full line). Object: 8 cm "bakelite" + stationary scatter grid. Distance to focus 90 cm. 40 kV, 1 mA.

Figure 3. Set-up for X-ray examination of pipe on a continuous basis. X-ray source is mounted on long beam extending into the pipe. Unit to left of the operation is X-ray control console. The enclosure is a ray-proof protective shield.

times smaller area. The total luminous flux is therefore radiated by an 80 times smaller image. The total brightness amplification resulting from the two above-mentioned factors amounts to at least 1,000 times.

The image radiated in visible light by the viewing screen is observed by an optical system which enlarges approx. 9 times. This optical magnification does not alter the brightness according to Abbe's law. The X-ray image observed through the optical system is then seen at a magnitude as if it were viewed directly on a normal fluorescent screen in its normal up-side-up orientation.

One of the interesting aspects of the image intensifier is that its high light gain enables the effects of single X-ray quanta to be observed. If the screen of the image intensifier is being observed at very low X-ray intensities with maximum optical gain (i.e. fast lenses with high magnification) the observed image exhibits a random fluctuation of light level at points all over the screen. The effect may be likened to that of "noise" on an electrical line. But in this case, the noise-like effect is connected with the relatively small number of X-ray quanta involved in forming the luminous image. At low X-ray intensities, the rate at which quanta strike a particular point may be intermittent enough to allow perception of the discontinuous nature of the radiation: i.e. the quantum effect.

The numbers of quanta involved in the different image-steps in fluoroscopy with, and without the image intensifier are shown diagrammatically in figure 2. The integration time of the eye, that is, the time during which the eye is able to co-ordinate a certain number of light quanta into a single light-impression, is assumed to be 0.2 sec.

In fluoroscopy without the image intensifier, only a very small fraction (roughly 0.02%) of the light from the screen enters the pupil of the eye. In the complete image transmission chain, then, it is at the retina that the number of quanta per image-element is smallest; the screen must absorb 100 X-ray quanta to produce one effective light quantum on the retina. Hence the perception of detail is fundamentally limited by the relative fluctuations in the number of quanta effectively absorbed by the retina.

In fluoroscopy with the image intensifier, however, the number of light quanta is so increased by the 1,000 times luminance intensification, as to exceed the number of X-ray quanta absorbed; here, then, perception of details is limited by the number of absorbed X-ray quanta.

The smallest numbers of quanta are then a factor of 40 larger, and the relative fluctuations a factor of

$$\sqrt{40} \approx 6X$$

smaller than in fluoroscopy without the image intensifier; the theoretical minimum perceptible contrast (for a given detail size) is therefore likewise smaller by a factor of 6.

If the fluctuations in the number of X-ray quanta could be neglected, the factor by which the minimum perceptible contrast is reduced by the 1,000 X luminance intensification would be very much larger. In fact, such an improvement would be obtained if the light from the screen were generated, not by X-rays, but by a very much larger number of relatively low-energy quanta.

An important use of the image intensifier is in industrial radiography. This is the technique employed in checking welds in pipeline and pressure vessels such as boilers. By X-raying the weld, cracks or other flaws are revealed. Generally film is used to record the examination. But by substituting an image intensifier for the film, the X-ray image can be viewed directly and a continuous examination of the pipe is possible. Figure 3 shows a set-up for examining large pipe in a continuous fashion.

Some of the advantages of the image intensifier are:

a) Economy — The film costs of some companies using X-ray inspection of welds in pressure vessels and precision castings runs as high as $10,000 per month. By substituting an image intensifier, the use of film can be eliminated except in these cases where a record document is required or when extreme sensitivity is important.

b) Continuity of observation — In a continuous production line, X-ray inspection can be accomplished in continuous fashion. The production flow does not have to be stopped to allow film to be wrapped around the item and the exposure made. In the medical field, observation of dynamic processes in the body is made possible. In some instances, diagnosis of certain defects is extremely difficult without this advantage.

c) Safety — Because the X-ray intensity required to produce an acceptable image is considerably less than that required for conventional fluoroscopy or radiography, the safety to the operator (and in medicine to the patient as well) is markedly enhanced.

In connection with this last feature, it is possible to combine the image intensifier with closed circuit television. The pickup camera is mounted directly on the image intensifier and the monitor is located at some remote location. This enables the observer to view the X-ray image with complete freedom from any radiation hazards. Additionally, if the object under examination is potentially dangerous (concealed bombs, the innards of mechanical devices which might explode or break up, areas with intense radiation from other sources, etc.), X-ray examination poses no danger for the observer.

Another system employs a movie camera in conjunction with the image intensifier. X-ray movies are particularly useful in medical work concerned with such active organs as the heart and digestive system. Because of the amplification of the image intensifier, ciné-radiography of humans can be accomplished without the risk of a radiation overdose.

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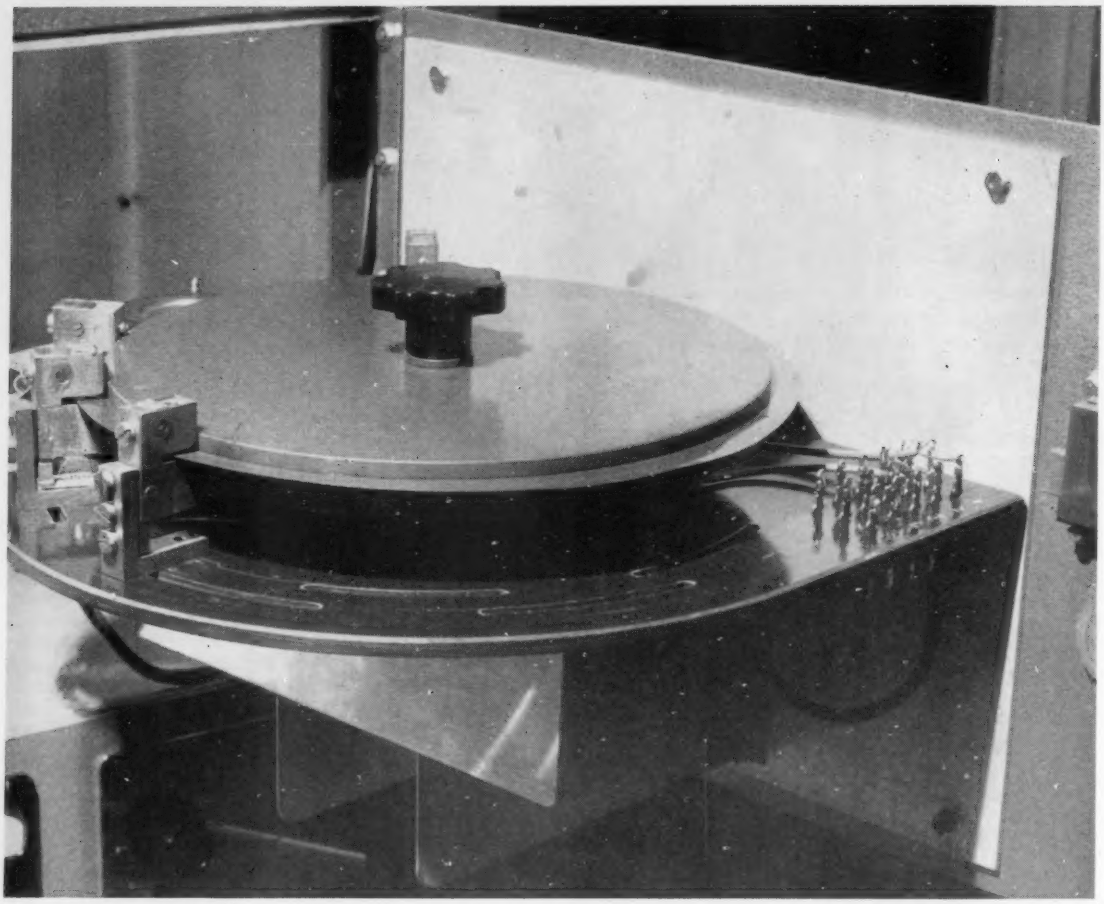


Fig. 1 Heart of the DSR system. Magnetic heads, left can be adjusted. Maximum delay is ½ sec. (600 feet from source)

New amplification technique makes sound quite natural

D. GORDON AULD, P.ENG.*

Public address systems covering large audiences have always been an acoustic problem because of the difference in time sound waves take to travel from differently placed loudspeakers. The problem has now been overcome and this paper describes the new system—called DSR—and its installation for the first time in Canada.

In the new year-round Queen Elizabeth Theatre of the Canadian National Exhibition, Toronto, the audience are able to hear sounds from the stage in perfect clarity, wherever they are sitting, without any suggestion of artificial amplification.

Until now, when a voice had to be relayed over a large area, extra "voices" were added to the original by the installation of loudspeakers until the whole area—it was thought—was adequately covered. With this old system, because sound takes time to travel from one part to another, a listener first hears the loudspeaker nearest to him. Then, a fraction of a second later, in different degrees of loudness, he hears the same sound from other loudspeakers. This happens with every syllable, and the result is the confusion and strain of listening to what appear to be three or four people speaking at once. In a building

*Engineered Sound Systems Ltd., Toronto

with even a slight echo, listening becomes almost impossible. The error has been in assuming that, if one voice could reach a hundred people, then ten voices would be required to reach a thousand people!

In the Queen Elizabeth Theatre, the problem was solved by Engineered Sound Systems Limited, Toronto, using a new method called "Delayed Sound Reinforcement." With DSR, there must be only one voice—that of the person speaking. If that voice will not travel far enough to cover the audience, it must be replenished on its way; it must be reinforced or boosted as it gets weaker with distance. With DSR, loudspeakers are used, but each is co-ordinated with the other and with the source of the sound by using a delay system which records and repeats the voice through the loudspeakers at precisely the right instant for each one of them to reinforce the original sound wave from the stage as it passes by. The original sound is thus preserved and replenished by the loudspeakers, but they no longer can be distinguished one from another. To the listener, there is no confusion from "other voices"; the sound is clear and natural and each member of the audience feels the speaker is addressing him personally, due to the stereophonic effect produced.

Magnetic delay mechanism

The "heart" of the DSR system is the magnetic delay device (fig. 1). This consists of a motor-driven turntable, 10″ in diameter, on which is clamped a thin, oxide coated plastic disc with the edge exposed. A number of magnetic heads are located around the periphery of the mounting so that they engage the disc over its extended edge. Contact pressure between the heads below and the disc, is maintained by weighted blocks sliding down in guides on the head mounting brackets. The record and erase heads are fixed in position, but the playback heads may be moved in slotted mounting holes to provide any angular delay required. Up to five separate pickup heads can be installed, which makes it possible to have five different delay coefficients in any one installation. Each pickup head feeds an individual power amplifier and loudspeaker installation.

The disc rotates at a speed of 50.4 rpm, which gives an equivalent "tape" speed of 26.376 in. per sec. At this rate, one inch distance between a pickup head and the recording head corresponds to the time sound takes to travel 45.5 ft. (0.030 sec.). From this factor, it is relatively easy to determine the approximate location for the pickup heads when making initial adjustments. This factor also determines the minimum delay possible since the record and pickup heads cannot be closer than 1 in. to one another. The maximum possible delay in this equipment corresponds to a distance of approximately 600 ft. (½ sec.). The heads are locked in position after final test of the installation.

The magnetic delay mechanism and associated erase oscillator (40 kcs.) recording amplifier, playback amplifiers and power supplies are rack mounted as a complete DSR assembly. In addition, the DSR rack contains an input mixer panel, consisting of a line amplifier fed by four separate plug-in preamplifiers designed to match either microphone or phono inputs. Each preamplifier has its own gain, bass and treble controls, which facilitates optimum setting of frequency response and level of each channel depending upon the type of input feed. This is important since, with DSR, adjustment of response for speech input can have a marked influence on the naturalness and stereophonic effect obtained.

The ultimate effectiveness of the illusion created by a Delayed Sound Reinforcement system depends to a large degree on a thorough evaluation of the building in which it is to be used, and the best possible positioning of the loudspeakers. Unfortunately, optimum positioning is not usually possible due to overweighing architectural or aesthetic considerations.

In general terms, however, (fig. 2) the loudspeakers nearest to the microphone should be placed as close to the actual source of sound as possible. The closer they are,

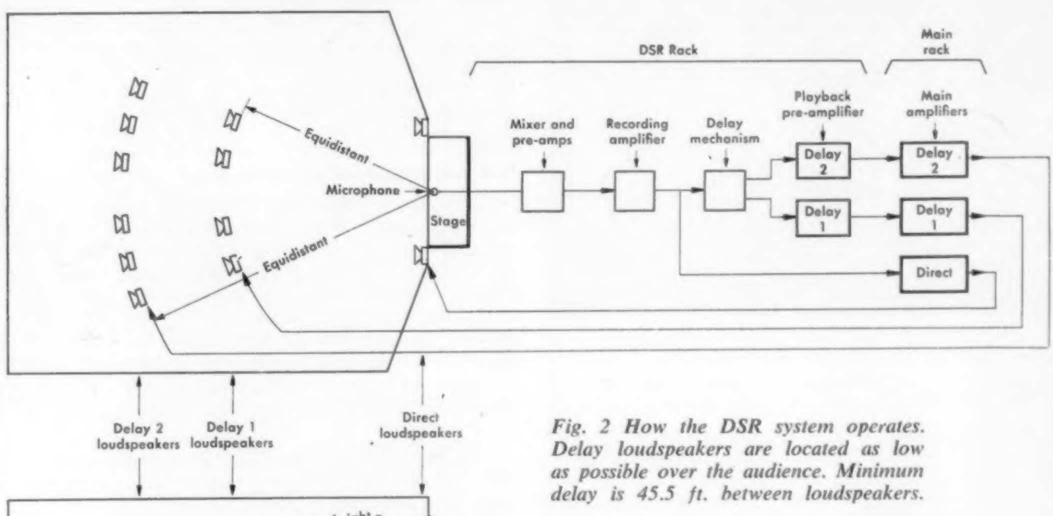


Fig. 2 How the DSR system operates. Delay loudspeakers are located as low as possible over the audience. Minimum delay is 45.5 ft. between loudspeakers.

the better the illusion that loudspeakers are not in use at all. Limiting factors are line of sight and feed-back from loudspeaker to microphone. The loudspeakers nearest the microphone have no delay factor and form the backbone of the system. They are usually identified as the "direct" loudspeakers and are positioned so that their beam is directed slightly downwards on to the heads of the listeners. When DSR is employed, these speakers are tilted down so that their narrow high frequency beam just reaches into the area covered by the first delay loudspeaker. The delay loudspeakers are generally located over the audience as low as possible without obscuring the view of the stage from any position in the audience. The distance from the source of the sound (stage or the direct loudspeakers) of all loudspeakers connected to any one delay amplifier should be as nearly equal as possible.

When determining their position, account must be taken of the built-in "minimum delay" of 45.5 ft. in the magnetic equipment. The angle of tilt of the first delay loudspeakers is determined by their distribution pattern and, if more than one delay is used, the area covered by the adjacent delay loudspeakers. The high frequency beam of the first delay loudspeakers should just reach into the area covered by the second delay loudspeakers, and so on.

In practice, considerable adjustment of these criteria may be necessary as evidenced by the installation in the Queen Elizabeth Theatre, where the only possible position for the direct loudspeakers is in a sloping section of the theatre ceiling, directly above the procenium arch (fig. 3).

Fig. 3 Position of direct and delay loudspeakers in the Queen Elizabeth Theatre. Distance between is about 52 ft.

Here the loudspeakers and their enclosure were set into a splayed opening in the ceiling with the entire opening flush covered with a bronze anodized expanded metal aluminum grill.

The positioning of the single set of delay loudspeakers was also dictated by architectural and aesthetic considerations, which necessitated that they too be located in a splayed opening in the ceiling, identical in finished appearance to that necessitated by the location for the direct loudspeakers. Initially, a point had to be found which was at least further than the minimum built-in equipment delay distance from the direct loudspeakers; which was in an area adjacent to a catwalk over the ceiling; which was in

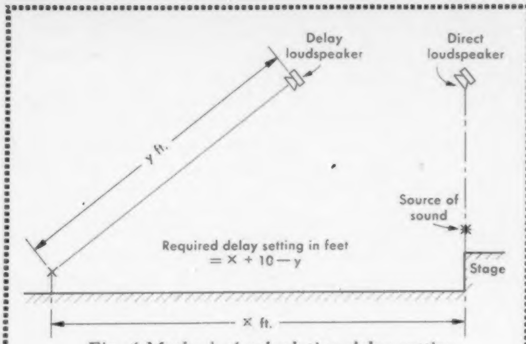


Fig. 4 Method of calculating delay setting

an area free of air conditioning and ventilating ducts and equipment; and, which was at a point which had close to the same delay coefficent for all seats in the back rows on the main floor of the theatre, as well as those in the front, middle and rear of the balcony.

By a happy coincidence, one of only two architecturally feasible locations, located approximately 52 ft. from the direct loudspeakers, proved to have a suitable delay coefficient, calculated as shown in fig. 4. In such a ceiling installation, consideration must be given, not only to the distance of the listener from a point directly below the direct loudspeakers at the front of the theatre, but also to the distance that the sound must travel from the delayed loudspeakers down to the listener. This introduces an "acoustic" delay which must be deducted from any electrical delay to be provided by the DSR equipment proper.

With DSR installations, it has also been found that an additional delay of approximately 20 milliseconds (equivalent to about 18 ft.) enhances the stereophonic effect and, for this reason, the formula delay (ft.) = $x + 10 - y$, includes a nominal extra 10 feet of distance for use when making preliminary calculations of delay loudspeaker position. Exact delay is obtained by precise adjustment of the delay mechanism during final test of the system. In any instance where the calculated delay is less than 45.5 ft., that loudspeaker position must be rejected since it is less than the minimum delay possible with this particular equipment.

Test, adjustment and operation

Testing and adjustment of a DSR system is perhaps more painstaking than conventional systems, but it is no more difficult. Factors which enhance or detract from the desired naturalness and stereophonic effect, are a properly adjusted frequency response on speech and on music; the over-all maximum power level employed; the relative relation between the volume distributed by the direct and delay loudspeakers; the actual delay coefficient selected; the manner in which the speaker uses his voice at the microphone, and the skill of the operator at the control console.

Initial tests involve the direct loudspeaker system only. This consists of concurrent adjustment of microphone input bass and treble controls, as well as the direct amplifier gain control, to give adequate volume—even in a full auditorium—without too much reverberant noise caused by excessive bass response and without loss of naturalness of voice caused by too little bass. Treble response is not too much of a factor unless the reproduction appears to have too much treble. It might be necessary at this time to check the tilt of the direct loudspeakers to obtain the desired distribution pattern.

Fig. 5. Bay and sound console of DSR system open for maintenance. Amplifiers are all-transistor. Main amplifier controls are preset and locked.

The second phase is the adjustment of the output level of the first delay loudspeakers. This is accomplished, while someone is speaking into the microphone, by adjusting the volume of the first delay amplifier until the delay loudspeaker can be clearly heard above the direct loudspeakers and then slowly reducing the volume until a level is reached where the delay loudspeakers are merely augmenting the volume. Too much volume will destroy the illusion that all sound is coming from the stage, and will also reduce the clarity in the area nearer the stage. The bass control of the delay amplifier should also be adjusted as previously indicated. Precise adjustment of the No. 1 magnetic pickup in the DSR can now be made based on actual listening tests.

If the system has other delay areas, they are adjusted next, with a gradual tapering of level from one delay group to the next. The direct loudspeakers must be loudest; delay 1 area at reduced volume; delay 2 area at further reduced volume, etc. Insufficient tapering will cause an echo or reverberant noise to interfere with sound near the stage, while too much tapering may leave insufficient volume at the back of the building when it is fully occupied.

In all cases, where music or singing is to be reproduced, the bass cut on that particular input channel should be limited. For this reason, in a DSR system it is desirable to save several different input channels, each with frequency response adjusted for one of the particular forms of sound input.

In operation, when using DSR equipment, it is always best to tend to use as little volume as possible. The advantages of this form of sound reproduction are in clear and unmasked distribution of sound, without the use of excessive volume. Naturalness and the sense of direction are lost if the volume is too high.

With DSR, speakers should be encouraged to speak up but not shout into the microphone since this, too, creates reverberant noise in all directions. The equipment is wasted if a speaker is of the impression he can throw his voice and attempts to do so.

The sound system complementing the Pamphonic Reproducers DSR bay in the Queen Elizabeth Theatre, though generally conventional, has been specially designed and constructed for the purpose, with particular emphasis on quality of reproduction, reliability and ease of service.

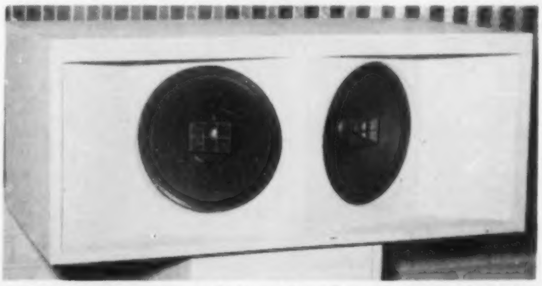
The main console amplifiers and mixer turret are of integral construction, as shown in fig. 5. Input mixing of six Altec-Lansing Type 670-B microphones has been provided, as well as means for mixing a tape input, and two Garrard Model 301 Transcription Motors equipped with General Electric Model A1-501 "Baton" Arms and RPX-052A Cartridges. Each low level cartridge is preamplified and equalized in accordance with RIAA curve by means of Fisher Type TR-1 all-transistor Preamplifiers. All recorded inputs can be used for sound effects when desired, through a special mixing panel and separate amplifier with rear-stage mounted loudspeaker. Provision has also been made for mixing input feeds from three lines—the projection room, the adjacent kitchen demonstration theatre, and an external remote pickup line.

To facilitate final adjustment of frequency response to suit different types of input signal, DSR preamplifiers Nos. 1 and 2 receive a microphone feed; No. 3 is a phono and tape input; and No. 4 is reserved for "line" inputs.

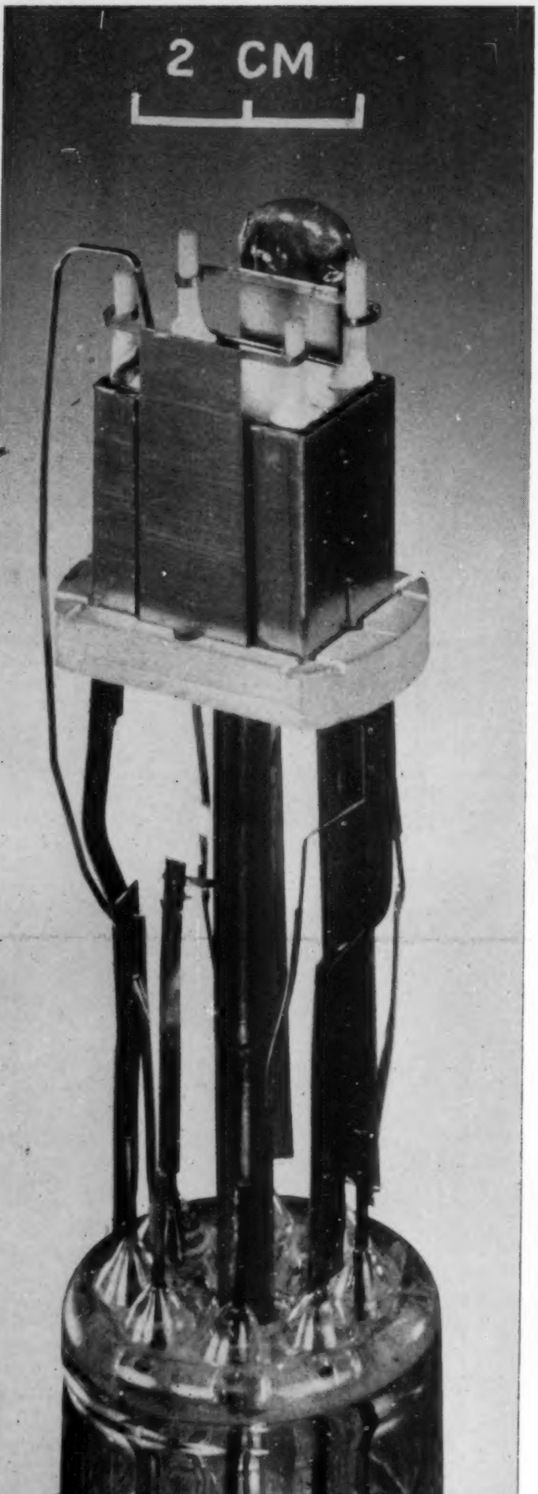
The direct, delay, and sound effects amplifiers mounted in the console are all Northern Electric Type R-6EB of 20 watts output. The output of these is directed to their respective main theatre speakers, to three office monitors, to the kitchen theatre sound system and to a tape recording output, as well as the control room monitor loudspeaker.

All the main theatre loudspeakers are 12 in. Altec-Lansing Type 601-A Duplex High and Low Frequency types, with the direct and delay loudspeakers mounted in pairs in specially designed enclosures to match the splayed openings in the theatre ceiling.

Operator cueing of recorded material is possible through a separate cue amplifier. Meters indicating level at the DSR recording input, and at the output of each of the main amplifiers enable the operator to ensure the naturalness and sense of direction of sound. END



Enclosure houses two 12 in. Altec-Lansing Type 601-A's.



Partly assembled omegatron shows the internal construction

P. A. REDHEAD & L. R. McNARRY*

High sensitivity, simplicity are features of new omegatron

The omegatron is a mass-spectrometer that is small, highly sensitive and easily constructed. Extremely high resolving power can be obtained at low masses and successful operation can be achieved at very low pressures. Its principal uses are as a leak detector, a gas analyzer in sealed-off systems at low pressures, and an analytic mass-spectrometer of moderate precision in the low-mass range.

*National Research Council, Radio & Electrical Engineering Division, Ottawa.

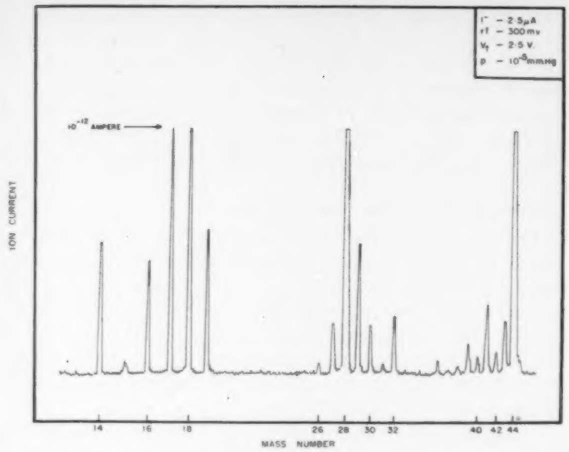


Fig. 1. Mass spectrum of a gas tested in the omegatron

The omegatron, first described by Hipple,[1] is a miniature mass-spectrometer which uses the cyclotron resonance to separate ions of different mass. As in the more conventional types of mass-spectrometer a record is obtained of the composition of a gas sample in terms of the charge-to-mass ratios of the ions formed. Fig. 1 is a typical record obtained with the omegatron showing the relative amounts of residual gases present within the omegatron in the range from mass 14 A.m.u. (nitrogen) to mass 44 (carbon dioxide).

The omegatron is in many respects similar to the cyclotron on a much smaller scale. A simple form of the omegatron is shown schematically in Fig. 2. A tungsten filament produces an electron beam of small diameter which is accelerated by about 50 volts and then passes through a small hole into a metal box (a cube of 2 cm on the side) and leaves the box through another hole where it strikes the electron collector. All the electrodes of the box are at the same DC potential, but the top electrode is insulated from the others and a small RF voltage is applied to it from a signal generator. The strong magnetic field applied along the axis of the electron beam prevents the beam from spreading.

The gas to be analyzed is introduced into the interaction box at a very low pressure (less than 10^{-5} mm Hg) while the omegatron is continuously pumped. The electrons within the interaction space produce positive ions by collision with the molecules or atoms of the gas sample.

The natural frequency of rotation of a charged particle in a magnetic field is called the cyclotron frequency, and is given by

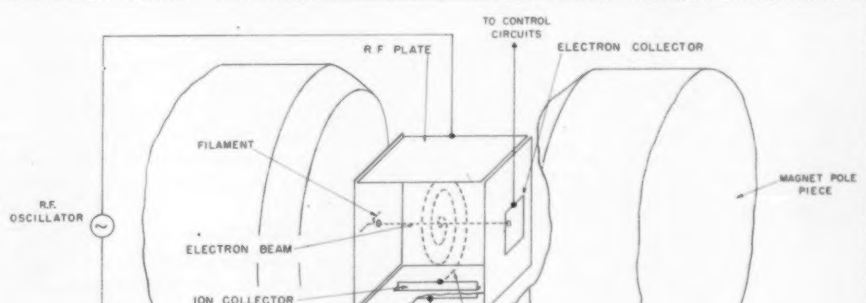
$$f_c = 1.525 \frac{Hn}{M} mc \quad \ldots\ldots\ldots \quad (1)$$

n = charge on the ion (in units of the electronic charge),
M = mass of the ion (A.m.u.),
H = magnetic field (kilogauss).

When the frequency of the applied r-f signal is precisely equal to the cyclotron frequency of the ions of one particular mass, these ions will gain energy from the RF field and spiral outwards in a plane normal to the magnetic field until they strike the ion collector: these ions are called the resonant ions. All other ions of different mass (the non-resonant ions) perform complicated orbits,[2] but none of these orbits expands continuously as does the resonant ion orbit. By proper adjustment of the amplitude of the r-f signal the resonant ions alone can be made to strike the ion collector. The current to the ion collector is then amplified by an electrometer amplifier and fed to a recorder.

Since the applied frequency for the resonant ions must satisfy Eq. (1), we can calculate the charge-to-mass ratio of the resonant ion if the magnetic field is known. A mass-spectrum of the ions present in the omegatron can thus be produced by slowly varying the magnetic field or the frequency of the applied r-f signal, and recording the ion collector current. If we use a fixed magnetic field and sweep the frequency then mass is inversely proportional to frequency. The inconvenience of this non-linear scale is more than compensated by the simplicity of the associated circuits and the use of a permanent rather than an electro-magnet.

Fig. 2. Schematic of omegatron showing principle of operation



Resolving Power

The ability of a mass-spectrometer to discriminate between ions of adjacent mass is termed its "resolving power" and is defined as $\frac{M}{\Delta M}$ where M is the mass of the resonant ion and ΔM is the base-width of the peak on the mass-spectrum corresponding to the ion of mass M. The resolving power of the omegatron is given by

$$R = \frac{M}{\Delta M} = 48\frac{R_0 H^2}{E_0 M} \quad \ldots\ldots\ldots \quad (2)$$

R_0 = spacing of ion collector from electron beam (cm),
E_0 = peak RF field (volts).

Since the resolving power is inversely proportional to the ionic mass, the omegatron has extremely high resolving power at low masses. A resolving power of 10,000 is possible at unity mass. It is also apparent from Eq. (2) that the resolving power increases as the magnetic field is increased or the applied RF voltage is decreased.

To obtain the predicted resolving power in practice the magnetic and electric fields must be extremely homogeneous. The magnetic field must be uniform over the working volume of the omegatron to a degree determined by the desired resolving power; i.e., if a resolving power of 10^3 is required then the magnetic field must be uniform to better than 1 part in 10^3. Uniformity of the electric field is also essential to allow operation of the omegatron at low values of r-f field where high resolving power may be obtained. Uniformity of the electric field is obtained by inserting a system of electrodes between the two r-f plates which act as a potential divider and maintain the field in the interaction space uniform. One simple way of achieving uniformity of field is by means of a square-section helix of resistive wire connected between the two r-f plates; this type of construction is shown in an exploded view in Fig. 3.

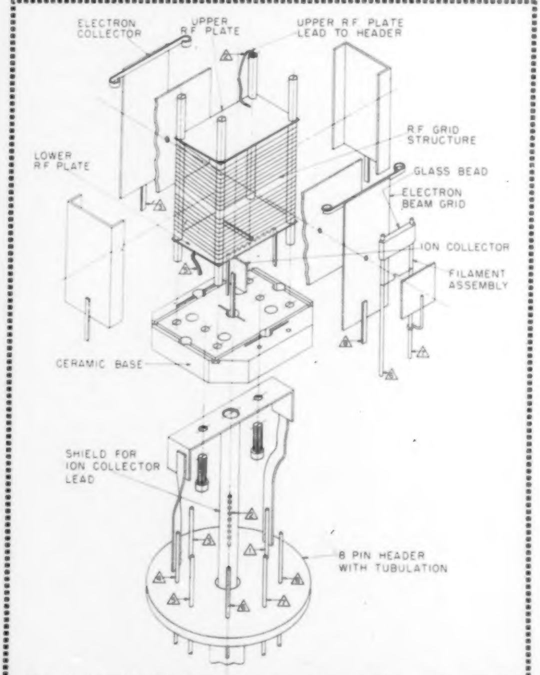


Fig. 3. Exploded view of omegatron with resistive grid

Limitations of the Omegatron

The non-resonant ions in the omegatron perform orbits of small diameter around the electron beam and create a large space-charge in this region. At high gas pressures this space-charge prevents proper operation of the omegatron; satisfactory operation can only be obtained at pressures below about 10^{-5} mm Hg. Useful mass-spectra can be obtained at pressures as low as 10^{-10} mm Hg.[3]

The principal difficulty which has prevented wider application of the omegatron is the existence, under certain conditions, of oscillations in the electron-ion space-charge which result in a current to the ion collector even in the absence of an r-f signal. This spurious current increases the background level of the mass-spectra and prevents operation of the omegatron at very low RF voltages, thus degrading the best obtainable resolving power. The causes of these oscillations are not fully understood but the range of experimental conditions have been established within which oscillations do not occur and proper operation of the omegatron can be obtained. The principal conditions necessary to prevent these spurious effects are: (1) operation at low electron current (c. 5 μA); (2) accurate alignment of the magnetic field with the axis of the omegatron; (3) prevention of any electron reflection from the electron collector. Space does not allow a full discussion of the methods of preventing these spurious effects; a more detailed description can be found in Reference 4.

Construction and Circuits

The photograph shows one design of omegatron developed in the National Research Council Laboratories which contains a resistive grid for improving the uniformity of the electric field. The electrodes are made from Nichrome V, supported and aligned from a ceramic insulator, and enclosed in a glass envelope.

Fig. 4 is a simplified circuit diagram of the auxiliary equipment. The mass sweep is obtained by a motor drive attached to a commercial signal generator. The voltages for the omegatron are all obtained from batteries. The positive ion current is amplified by a commercial vibrating-reed electrometer and recorded on a 50-millivolt recording potentiometer.

Applications

The omegatron may be used as an analytical mass-spectrometer where it is most useful in the mass range of 1 to 50; it has, however, been used to mass 200 though the resolving power at these high masses is poor. The omegatron has the advantages of cheapness and simplicity, but great care must be taken to achieve high analytic accuracy. Applications of the omegatron as a process-control monitor in the low mass range also appear promising.

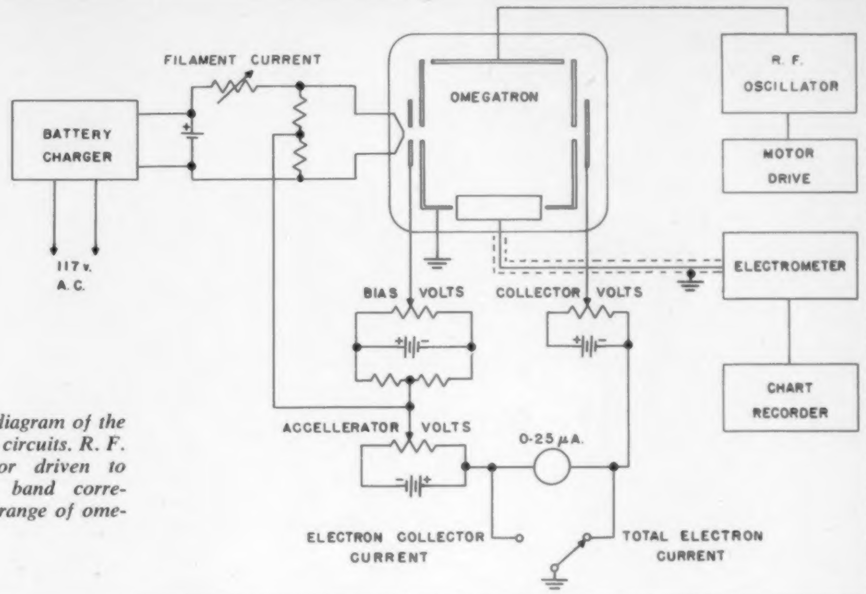


Fig. 4. Simplified diagram of the omegatron control circuits. R. F. oscillator is motor driven to sweep frequency band corresponding to mass range of omegatron.

The omegatron can be sealed directly to a vacuum tube and operated after the tube has been sealed-off. Analyses can then be made, down to extremely low pressures, of the residual and evolved gases in the system.

As a leak detector (using helium as the probe gas) the high sensitivity and simplicity of the omegatron are very useful. The use of the omegatron as a leak detector has been described by Bell.[5] END

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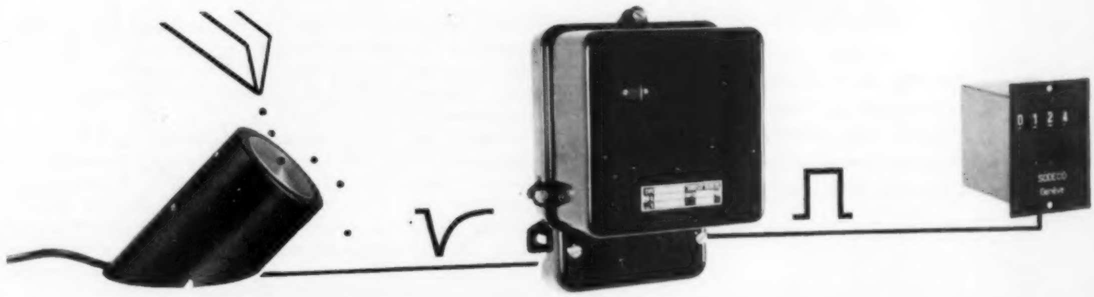
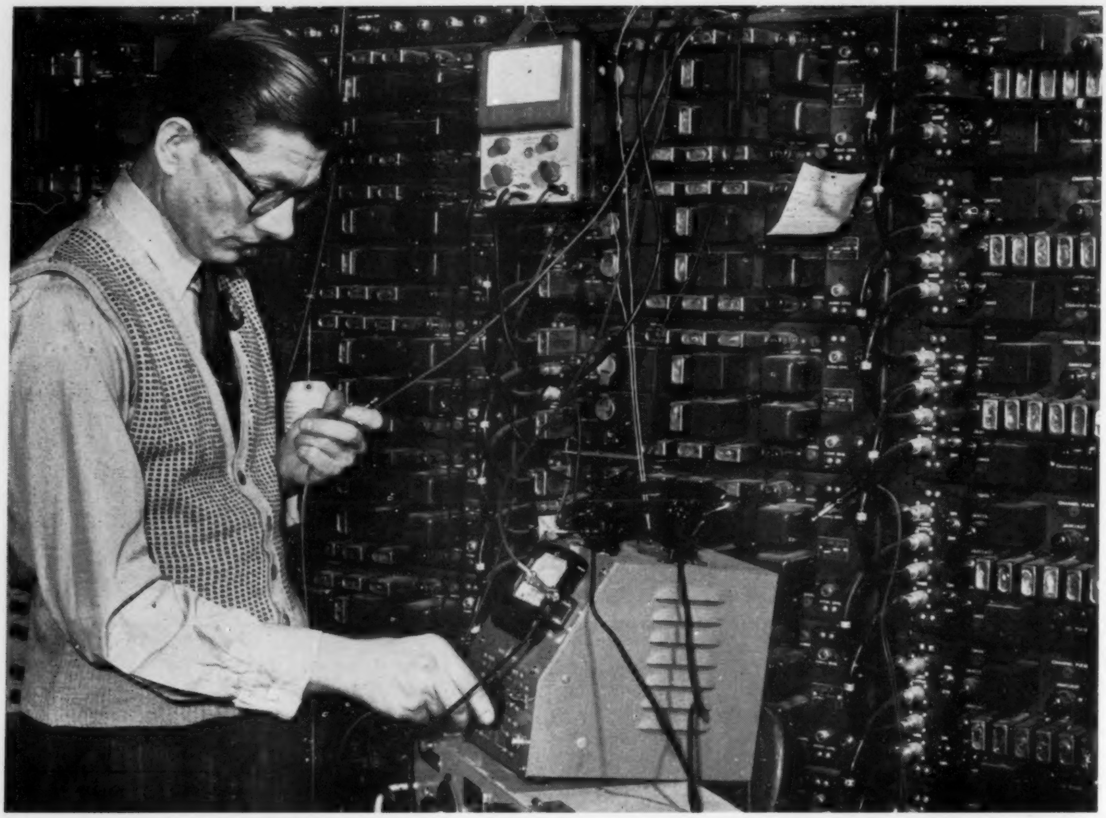
5. *Bell, R. L., J. Sci. Instr., 33, 269 (1956).*

Microphone is used to count small parts



Electromechanical impulse counters work best when the impulse series is an even square wave of constant amplitude and frequency. In practical applications, however, these conditions are rarely satisfied. The Sodeco company of Switzerland has overcome this problem with an adaptor that will accept impulses and convert them to square wave pulses to actuate the counter. Impulses of 1 millisecond duration and 17 millisecond interval will trigger the adaptor. In the illustration, parts to be counted are dropped onto a microphone diaphragm. The sharp impulses trigger the adaptor which generates square pulses to operate the counter. END



Electronic equipment is capable of reliable service but it must be properly designed, operated and maintained

Industry can solve many of today's problems by taking

A new approach to electronics

E. W. LEAVER, P. ENG. *

Even today, electronic controls and instrumentation are not widely accepted by industry. The author asserts that industry must adopt these new techniques and suggests ways in which electronics manufacturers can put their case

In spite of all the talk and discussion about the application of electronic techniques to industrial problems over the years, the applications have, in fact, been relatively few. I think it might be interesting to examine some of the reasons.

While the possible number of applications is enormous, the requirements are very diverse. From a manufacturing point of view, a great many are specific to a given industrial situation, and occupy the difficult and costly area of custom design and manufacture. Many require development work which costs time and money. As a result, not too many manufacturers can see the return that would make a venture in this field profitable.

The unfavorable manufacturing outlook is further accentuated by attitudes common in the industry market. Electronic apparatus is often looked upon with a great deal of suspicion. It is new in all its problems of concept, application and in maintenance. Because it may contain tubes, it is often considered just another version of a radio or television set, where years of high volume production

*President, Electronic Associates Ltd., Toronto

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and ruinous price cutting have devalued engineering and production achievement almost to the point of contempt.

Hence, electronic equipment is often thought of in terms of a cheap bag of tricks, not particularly reliable and even if used, readily obtainable from a cut-rate store. As parts are readily available, and there are so many "experts," some plants have wasted thousands of dollars "saving money" by building their own, a different version of the "do-it-yourself" craze.

Electronic firms themselves often aid in this devaluation, because they will sometimes manufacture at a loss in the hope of possible future profits! The factors that are forgotten in all this are: that development and design require a lot of high grade engineering, which is increasingly difficult and expensive to obtain, and which somebody must ultimately pay for, and that electronic instruments and equipment can and do make and save user industries a lot of money.

Everyone in industry should examine their operations realistically, find out what electronic equipment can do, be prepared to pay what it is worth, provide suitable operating conditions for the equipment, and give it full and fair opportunity to prove its worth.

Question of maintenance

Another curious anomaly in the thinking of many users and possible users of electronic equipment is in the area of maintenance. Everyone expects that in the case of mechanical contrivances something will go wrong once in a while, and that periodically someone will have to check it over and fix it up. No one suggests that motor cars are impractical, yet the manufacturer recommends an oil change and a chassis lubrication every thousand miles. At a speed of 30 miles per hour this means service after every thirty-three hours of use! Most industrial equipment requires frequent lubrication and inspection, yet, because we are used to it and consider it normal, it is accepted.

Admittedly electronic equipment requires less service than any other having anything like the same complexity. Every year provides improvements in this respect. Equipment designed for the Armed Forces, who are prepared to pay for premium components, will take almost unbelievable punishment.

Part of the difference in attitude toward electronic equipment may be due to the fact that it is comparatively new in the industrial field, and part because it does not usually fail in the same way as do mechanical devices, deterioration often being independent of use. Thus, a piece of electronic equipment may run for six months without a failure, or it may just as easily fail one day after arrival. This is something for which the buyer has to be prepared. It may be easier to reconcile him to this situation if it is realized that on the average the service required is much less than might be expected.

But there is no reason to assume that if a readily replaced vacuum tube should fail that there is something fundamentally wrong with the particular instrument, the principle upon which it operates, or all electronic apparatus. But there are plants where electronics are viewed with disfavor because of a single unfortunate experience, which usually has been caused by improper application, purchase of unsuitable equipment, often because it was cheap, or rejection after a minor failure without really giving the equipment a proper opportunity to show its worth.

Unfortunately, a large number of industrial users who could enjoy the benefits of these advances in technology are not doing so, not because they can't, but because they don't realize the true situation. Clarification is well worth while, for in some areas the advantages to industry are great. One example is the case of a control that saved its cost every week. These advantages are only going to continue to be realized if a healthy electronics industry is around to supply the necessary engineering, as well as the hardware, and a clear mutual understanding grows up between the supplier and customer.

Where electronics take over

The following check points may be helpful to a possible used of electronic equipment: 1. Where in our operations would a knowledge of speed, temperature, pressure, color, level, continuity, basis weight or density be useful? 2. What would be required in the range and accuracy of the measurements required? 3. What instruments are available to do the work or, if none are available, can such an instrument be designed and manufactured? 4. Is control desirable, and what would be required in the way of performance? 5. Are there control means available, and if none are, can such controls be designed and manufactured?

The potential user should be told that it is essential to:

1. Make sure you specify exactly what the equipment is to do, and do not increase your requirements after delivery. Equipment can be built to do almost anything, but more elaborate equipment will cost more.

2. Specify only as great a range and accuracy as is really required; cost usually increases much faster than accuracy.

3. Provide reasonable line voltages (in many plants equipment designed to operate at 115 volts are supplied 80 to 100 volts). Equipment can be supplied to operate at any voltage, but it must be so specified.

4. Provide a reasonable environment. Electronic equipment can be constructed to operate under almost any conditions, but it costs a lot more to waterproof, heat or cool equipment. Failure to specify poor conditions may result in the supply of unsuitable equipment.

5. On arrival of equipment, have it stored and handled properly. Electronic equipment like lots of other things shouldn't be handled like scrap iron.

6. Install the equipment properly. If it is fairly simple equipment, one of the plant people using the instructions supplied should do a satisfactory job. In the case of complex equipment, it will be worth money to have the manufacturer supervise the installation.

7. Operate the equipment as specified, and give it a fair chance to show what it can do. Make sure the people using it really understand it. A great deal of user dissatisfaction has been caused in the past by the person assigned not knowing what the equipment was supposed to do.

8. Avoid plant personnel making modifications. Cases exist where equipment has been modified to make it unworkable, when it was working normally.

9. Expect some maintenance, but avoid maintenance for maintenance's sake. A tube may fail any time and it is easily changed. Don't change a tube that has operated 3,000 hours; the chances are it will work another 3,000.

10. Don't hesitate to call on electronic manufacturers for information, not only for the equipment they normally sell, but as to what might be manufactured for a specific problem.

11. In the case of dissatisfaction with equipment, it is only common courtesy to tell the people who made it first.

12. Realize that electronic equipment is still strange to most people in industry, that it can provide special rewards, but it requires some special attention until plant personnel become acquainted with it.

I believe that if electronic manufacturers, and potential industrial users, can become acquainted with each other's problems, they will be solved to their mutual satisfaction, and the era of electronic instrumentation and control, so long discussed, may slowly but surely emerge. END

Arrangements for the XI General Assembly of IUGG have been under the direction of Professor J. T. Wilson (centre), vice-president of IUGG. Assisting him are J. A. Jacobs (left) and R. M. Farquhar.

1500 scientists at IUGG General Assembly ask:—

What has IGY achieved so far?

The International Geophysical Year is now entering its third month and scientists are meeting in Toronto to discuss the progress of this vast scientific project. The event is the XI General Assembly of The International Union of Geodesy and Geophysics.

The IGY is a co-operative project in which the IUGG has joined with other scientific bodies including the International Union of Astronomy, the International Union of Scientific Radio and the World Meteorological Organization. The meetings now being held in Toronto will afford the first opportunity to discuss the progress of the IGY in its entirety and establish final plans for the remainder of "year."

About 1,500 experts in the earth sciences are attending the meetings at the University of Toronto during the assembly period of September 3-14. These include a delegation of 57 scientists from Soviet Russia.

Two distinguished speakers will give addresses in Convocation Hall during the assembly. On Friday, September 6, the noted Russian scientist E. I. Tolstikov will lecture on "The Arctic And Antarctic Program of the IGY." On Thursday, September 12, the topic of the address by Professor L. V. Berkner will be "The Rocket and Satellite Program of the IGY." Both talks commence at 8.00 p.m. and are open to the public.

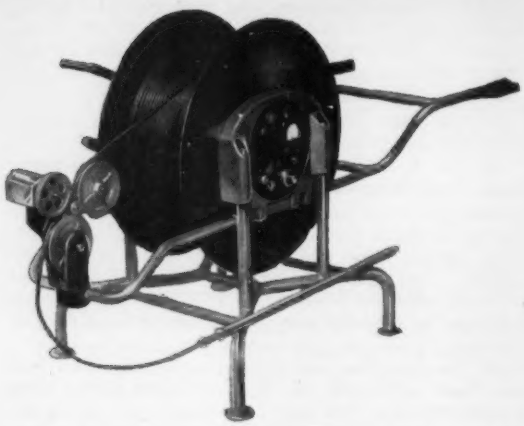
Typical subjects to be discussed by the delegates at the XI General Assembly are: the age of the earth (now estimated at 4½ thousand million years); polar wandering (different locations of the tropical regions in past ages); the warming cycle (whether the earth's climate is getting warmer); measuring distances between continents by radar; the origin of cosmic rays and their immense energies; sun spots and solar flares; jet streams in the atmosphere; the true shape of the earth; magnetic storms and radio communications; how rockets explore the upper atmosphere; the northern lights; the record of the glaciers; the cause of airglow; the earth's interior; deep ocean currents; artificial satellites; and methods of geophysical prospecting.

The International Union of Geodesy and Geophysics was formed at a meeting held under the aegis of the League of Nations in Brussels in 1919. It comprises seven associations with members from forty-six countries. General Assemblies are held every three years for the purpose of planning co-operative programs, holding discussions, presenting papers and electing officers.

Arrangements for the present Assembly have been under the direction of J. T. Wilson, Professor of Geophysics, University of Toronto. Professor Wilson also currently holds the position of vice-president of the IUGG. Included in the events will be technical discussions, a trade exhibition in Hart House, public lectures, and field trips to Niagara Falls, the Muskoka District and the Stratford Shakespearean Festival. END

Dr. A. K. Mousuf*

Electromagnetometer prospects in drill hole



Probe on cable of portable measuring unit is lowered into drill hole. Signals are amplified and measured by meter

Among the subject to be discussed by scientists at the XI General Assembly of IUGG will be the structure of the earth. This also affects the mining industry which has a direct interest in finding ore bodies. The electromagnetic induction method of prospecting for conducting bodies (base metal sulphite deposits primarily) was first used in ground surveys. In 1949 the first fully airborne survey was carried out and now the technique is being extended to drill hole investigations

In mining work, drill hole measurements are often useful for determining the proximity of ore bodies and the extent of mineralization. In this application, electromagnetic drill hole exploration may be considered as a means of extending the diameter of the drill hole and its importance could be best realized and appreciated when one considers the fact that in the history of mining exploration, there are numerous cases where commercial ore bodies have been missed by very short distances. Drifting or crookedness of drill holes is a contributing factor to this.

Until recently, drill hole surveys for the detection of conducting bodies had utilized only the resistivity method of geophysical prospecting. However, the inherent limitations of this method have restricted its use as a means of exploration. Conclusions have been drawn from field trials that the resistivity method is not particularly sensitive; a large amount of conducting material must occur in close proximity to the hole to produce a significant and distinguishable anomaly.

In contrast, the electromagnetic method is quite sensitive towards detection of conducting bodies and at the low frequencies that are generally used, the electromagnetic field itself is not appreciably affected by the normal resistivity variations in the barren rock. Consequently, significant anomalies are due only to bodies of high conductivity. A current field, however, is influenced by minor variation in resistivity to a much greater extent than is an electromagnetic field. Therefore, a minor variation in the rock resistivity produces as great an anomaly in a current field as does a body of high conductivity in an electromagnetic field. This makes it rather difficult to eliminate undesirable anomalies in the resistivity method.

Also, in the electromagnetic method of survey, a much larger region of wall rock is tested, and conducting zones at a greater distance from the drill hole could be detected. In addition to these, there is no necessity of making direct contact between the formations and the detecting unit which quite often presents difficult problems in resistivity logging where such direct contact is required.

The different types of measurement carried out in ground electromagnetic survey could also be similarly done, in the case of drill hole investigations with, of course, modifications of the technique wherever required. The simplest of these is the electromagnetic dip measurement. Recently, however, Sharpe Instruments Limited has developed an electromagnetic drill hole unit, model DHP-2 which utilizes a technique similar to that employed in the Swedish method of ground electromagnetic measurement. One of its major advantages lies in the fact that a variety of readings can be obtained for completeness in interpretation. Both main field and differential field readings can be taken with it. The main field reading gives the information regarding any distortion in the primary field due to the effect of the secondary field that may arise from a conducting body, whereas in the differential reading, the effect of the primary field is nearly eliminated and only the secondary field is measured.

The DHP-2 has already been field tested at several places both in Canada and the United States near known ore bodies. The results that have so far been obtained are highly satisfactory and it seems that there is a great potentiality for this particular technique of electromagnetic measurement in drill hole investigation towards detection of conducting bodies both close and far removed from the hole. The type of results one is expected to get with this unit in taking main field readings and differential field readings for the two cases where the ore body is located close and far from the drill hole have been shown in figure 1.

Description of the equipment

The DHP-2 is divided into three sections: (a) Exciting Unit, (b) Detecting Unit and (c) Measuring Unit.

(a) The exciting unit is made up of a gasoline driven motor generator set, control box and a large loop. The power output of the generator is 500 watts and the currents obtained are between 3 to 4 amperes at 1200 cps. As the exciting coil is a rather large affair, the conductor cable is in four parts on separate reels mounted on two packframes. On one side of the control box, there are two jacks for the generator plug and for the loop plug. The

*Sharpe Instruments Ltd., Willowdale, Ont.

meter on this side indicates the loop current. At the bottom of the control box, there are four switches (marked "TUNING" 1-2-3-4) for adjusting the frequency of loop current. Thirteen different switch arrangements are possible to match exciting loops of different sizes.

On the other side of the control box there are two meters for controlling and adjusting the frequency.

(b) The detecting unit consists of two similar detector probes, their design being controlled by the mechanical and electrical specifications. The detector probe consists of a few thousand turns of copper wire wound on an iron-cored bakelite tube and a built-in transistorized pre-amplifier. The length of the detector probe is 26 inches and its outside diameter is one inch. It is well suited for use in E_x and A_x types of holes which are the most popular ones.

(c) The measuring unit includes an amplifier with indicator, built in the drill hole reel, and 1,000 feet of cable for the drill hole. The unit is mounted on a strong but light weight carrying frame for the convenience of moving it from one drill hole to another. The signal strength is indicated by a microammeter which reads 100 micro amps for full scale deflection. A variable gain control allows decreased signal from greater depth to be read with the same intensity. A sensitivity switch which reads "LOW," "MEDIUM" and "HIGH" has been provided for obtaining greater sensitivity of readings which can be increased by factors of 2 and 20 by turning the sensitivity switch from "LOW" to "MEDIUM" and "HIGH." To check that proper signal is indicated by the meter, a phone jack is also provided.

How conducting bodies are located

The simplest method of surveying, and one over which considerable amount of control can be exercised, is to lay a horizontal loop on the surface. The size of the loop used is controlled by requirements such as range of exploration contemplated, depth of hole to be explored and disposition and size of the material sought. If a large range or depth of exploration is required, a large loop should be used. A 2,000-foot drill hole can be surveyed with a square loop of 1,500 feet per side. Normally, the loop is laid with the drill hole at the centre and an alternating current of 1,200 cps frequency is caused to flow in it by the motor generator power supply unit.

The survey is carried out in two runs. On the first run, a single detector is lowered into the drill hole, and since the field is attenuated with depth, the amplifier gain is adjusted for each position until the output meter is reading the centre of the scale. These readings are made at desired intervals and noted. On the second run, two detectors are interconnected by means of 50 feet of co-axial cable and differential readings are taken. The detectors are connected in parallel and wound in opposition and the signals from them are fed in at the input terminal of the main amplifier on the surface. Hence, in the absence of any conducting body, the resultant signal due to normal variation in the main field will be nearly zero or reduced to minimum. Variation in the signal would be due primarily to anomalous conditions; and since the ratio of anomalous signals to exciting field signals is increased by using the differential method, the sensitivity is correspondingly increased. Also, because of the variable gain settings, readings due to anomalies will be proportional regardless of depth. Once a conducting body has been located its azimuth determination with respect to the drill hole can be made by carrying out measurement with small loop laid successively in each of the four quadrants. Comparison with the profile readings taken previously will indicate in which quadrant the conducting body is located.

END

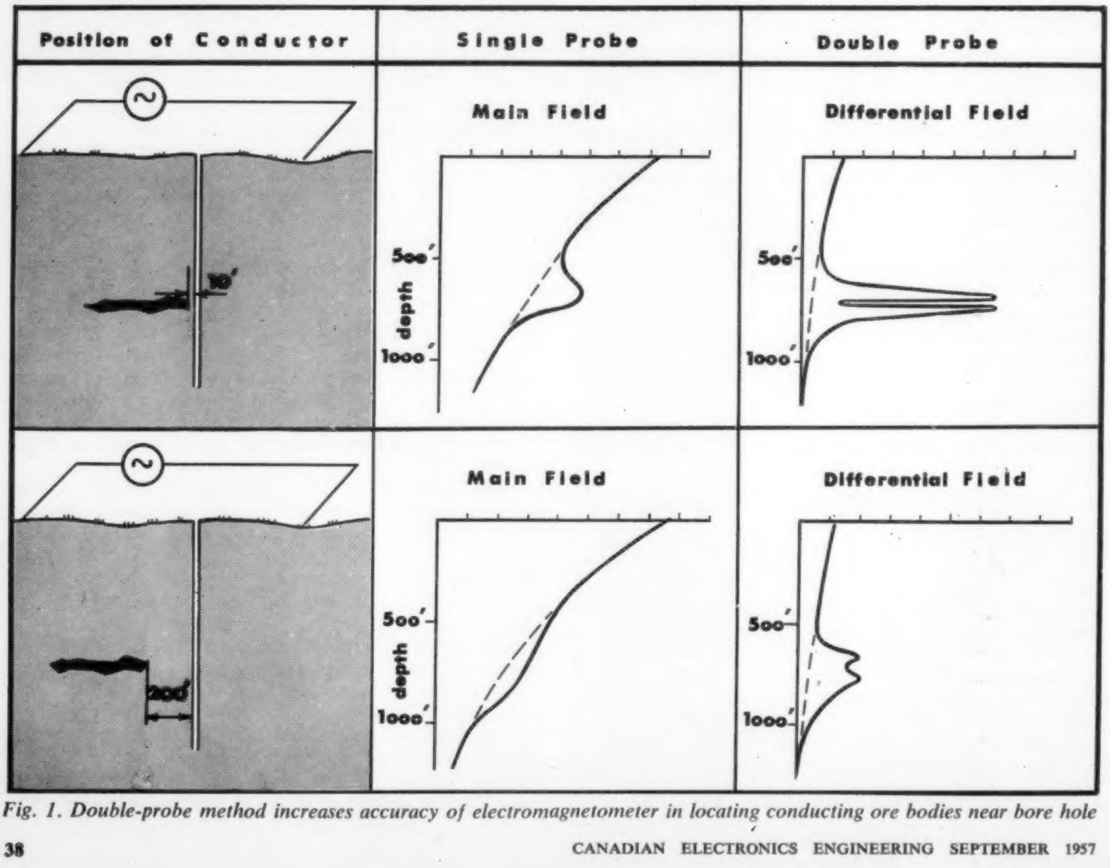


Fig. 1. Double-probe method increases accuracy of electromagnetometer in locating conducting ore bodies near bore hole

MAURICE PRICE, P.ENG*

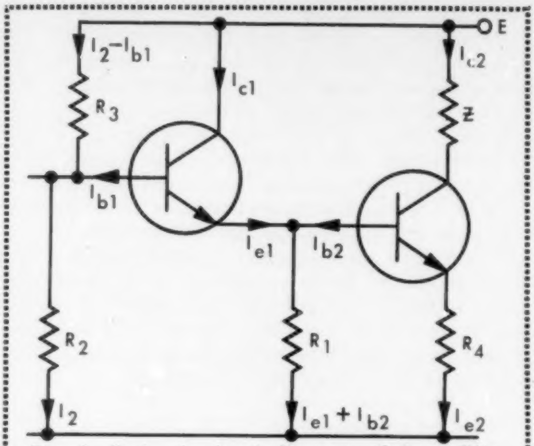


Fig. 1. Basic circuit of direct coupled amplifier.

The emitter-base direct coupled amplifier is suggested as a suitable general purpose arrangement offering the minimum number of components. A design procedure for the biasing networks is developed and various amplifier configurations are indicated using this basic arrangement. The application of decoupling to first stage is also considered.

Design procedures for emitter-base direct coupled transistor pair

The advantages of direct coupling between transistor amplifier stages have been recognized by many workers. They include:

(*a*) Possible reduction in the number of components.
(*b*) Compensation of transistor leakage currents.
(*c*) Reduced phase shift.

The loss in gain associated with direct coupling can generally be tolerated.

Two possible arrangements for direct coupling are collector-to-base and emitter-to-base. The second of these offers the greatest reduction in the number of components, since no collector load resistance need be used in the first stage. This arrangement is therefore studied in detail. The design revolves around the biasing of the stages with an examination of the stability of the operating points.

Basic arrangement

Figure 1 shows the dc connections for the basic emitter-to-base direct coupling. The collector cut-off currents I_{co1} and I_{co2} will affect the operating point stability of the stage in which they arise and of the other stage. Four stability factors may be defined to express the direct effects and the cross effects of these leakage currents:

$$S_{11} = \frac{\partial I_{c1}}{\partial I_{co1}}\ ; \quad S_{12} = \frac{\partial I_{c1}}{\partial I_{co2}}\ ; \quad S_{22} = \frac{\partial I_{c2}}{\partial I_{co2}}\ ; \quad S_{21} = \frac{\partial I_{c2}}{\partial I_{co1}}\,.$$

Using the nomenclature given in fig. 1, and assuming that the base-emitter potential is negligible, the four stability factors are found to be:

$$S_{11} = \frac{\left(1 - \alpha_2 + \frac{R_4}{R_1}\right) + \left(\frac{R_4}{R_2} + \frac{R_4}{R_3}\right)}{\left(\frac{R_4}{R_2} + \frac{R_4}{R_3}\right) + (1 - \alpha_1)\left(1 - \alpha_2 + \frac{R_4}{R_1}\right)} \quad .(1)$$

$$S_{12} = -\,[1 - S_{11}(1 - \alpha_1)] \quad \ldots\ldots \ (2)$$

$$S_{22} = \frac{\left(1 + \frac{R_4}{R_1}\right) - \frac{\alpha_2}{\alpha_1}[1 - S_{11}(1 - \alpha_1)]}{1 - \alpha_2 + \frac{R_4}{R_1}} \quad .\ (3)$$

$$S_{21} = \frac{\frac{\alpha_2}{\alpha_1}(S_{11} - 1)}{1 - \alpha_2 + \frac{R_4}{R_1}} \quad \ldots\ldots\ldots \ (4)$$

Further analysis leads to the following relationships:

$$\frac{R_4}{R_1} = \frac{\frac{\alpha_2}{\alpha_1}(I_{c1} - I_{co1}) - (1 - \alpha_2)I_{c2} + I_{co2}}{I_{c2} - I_{co2}} \quad .\ (5)$$

$$R_3 = \frac{E(S_{11} - 1)}{\frac{\alpha_1}{\alpha_2}\left(1 - \alpha_2 + \frac{R_4}{R_1}\right)(I_{c2} - S_{22}I_{co2}) - (S_{11} - 1)I_{co1}} \quad .\ (6)$$

$$\frac{R_4}{R_2} = \frac{[1 - S_{11}(1 - \alpha_1)]\left(1 - \alpha_2 + \frac{R_4}{R_1}\right)}{S_{11} - 1} - \frac{R_4}{R_3} \,.\ (7)$$

It is possible to fix one of the S factors in advance; S_{11} is selected for this purpose. Resistance R_4 is also fixed from considerations of the allowable loss in maximum output from the second stage. Thus the steps in the design are:

(*a*) Select values for S_{11} and R_4
(*b*) Find R_1 from (5)
(*c*) Find S_{22} from (3)
(*d*) Find R_3 from (6)

*Computing Devices of Canada Ltd., Ottawa.

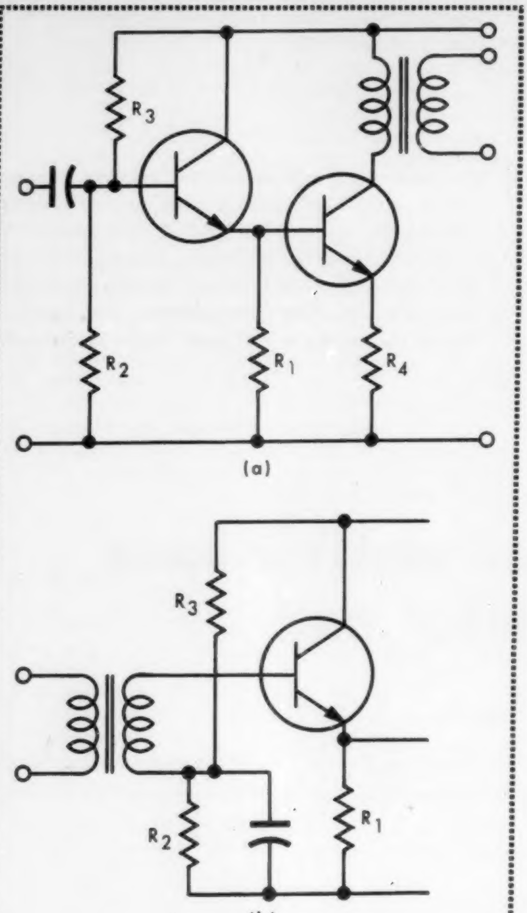


Fig. 2. Common collector-common emitter configuration, showing two variations of the input circuit. It may be unnecessary to bypass the resistance R_4.

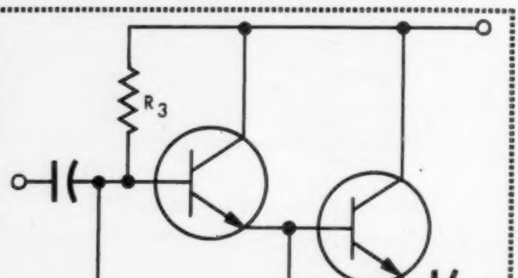


Fig. 3. Common collector-common collector configuration. This arrangement gives a very high input impedance. Input may also be transformer coupled.

(*e*) Find R_2 from (7)

(*f*) Check S_{12} and S_{21} from (2) and (4).

Note that S_{12} is negative, so that the operating point of the first stage may be compensated to some degree by the second stage. This may be compared with the collector-to-base direct coupling, in which the second stage may be compensated by the first. The latter is preferable, but in practice the S factors can be held to such low values that the emitter-to-base coupling is at little disadvantage on this score.

In practical applications, the potential difference across R_4 should be made about 0.2 to 0.5 of the supply voltage. S_{11} should be made about 1.5 to 3.0. With these values, the other S factors will be satisfactorily small and there will be little loss due to the shunting effect of R_1 and R_2 on the signal.

Alternative circuits

The basic circuit lends itself to a variety of amplifier configurations, some of which are shown in figs. 2 through 5. In all cases, the same basic design procedure applies. Probably the most useful of these arrangements is the common emitter-common emitter configuration of fig. 5. It may be unnecessary to bypass resistance R_4 since the loss in gain due to feedback via R_4 is counteracted by the increase of gain in the first stage due to the raised input impedance of the second. This applies if the shunting effect of R_1 is negligible. The beneficial effects of this un-bypassed resistance are obvious. For achieving high input impedances, the common collector-common collector arrangement of fig. 3 is very useful.

Design example

A specimen design will illustrate the order of magnitude of the various factors.

The data assumed are:

$\alpha_1 = 0.925 \qquad \alpha_2 = 0.94$

$I_{e1} = 2$ ma $\qquad I_{e2} = 5$ ma

$E = 28$ v $\qquad I_{co1} = I_{co2} \approx 0$

Taking $R_4 = 2{,}200$ ohms and $S_{11} = 3$, the following values are obtained:

(*b*) $R_1 = 6{,}350$ ohms

(*c*) $S_{22} = 1.38$

(*d*) $R_3 = 28{,}100$ ohms

(*e*) $R_2 = 27{,}900$ ohms

(*f*) $S_{12} = -0.78 \qquad S_{21} = 5.0$

These S factors are acceptable. Any of the amplifier configurations may be used with this basic design.

Application of decoupling

Decoupling may often be necessary for one or more of the following reasons:

(*a*) To prevent oscillation or instability in dynamic performance.

(*b*) To reduce the first stage collector voltage if the ratings of the first stage transistor so demand.

(*c*) To prevent ripple and other undesired signals from entering the amplifier via the bias networks.

The arrangement shown in fig. 6 introduces a decoupling resistance R_5. This enables one more parameter in the design to be fixed, and S_{22} is selected. The analysis follows that used for the basic arrangement above, with the same assumptions. The results are embodied in the design procedure given below:

(*a*) Find R_1 from $\frac{R_4}{R_1}$

$$= \frac{\frac{\alpha_2}{\alpha_1}(I_{c1} - I_{co1}) - (1 - \alpha_2)I_{c2} + I_{co2}}{I_{c2} - I_{co2}} \quad \ldots (5)$$

(*b*) Find R_3 from R_3

$$= \frac{E(S_{11}-1)\left(\frac{I_{c2}-I_{co2}}{I_{c2}-S_{22}I_{co2}}\right)}{(I_{c1}-S_{11}I_{co1})+I_{co2}\left[\alpha_1-\frac{(S_{11}-1)(S_{22}-1)I_{co1}}{I_{c2}-S_{22}I_{co2}}\right]} \quad . (8)$$

(*c*) Find R_5 from R_5

$$= \frac{(S_{22} - 1)(E + R_3 I_{co1})}{I_{c2} - S_{22}I_{co2}} - (1 - \alpha_1)R_3 \quad . \quad (9)$$

(*d*) Find R_2 from R_2

$$= \frac{R_4(S_{22}-1)\left(1+\frac{R_5}{R_3}\right)}{\left(1-\alpha_1+\frac{R_5}{R_3}\right)\left[\alpha_2 S_{22}-(S_{22}-1)\left(1+\frac{R_4}{R_1}\right)\right]-(S_{22}-1)\frac{R_4}{R_3}} \quad \ldots\ldots\ldots\ldots (10)$$

(*e*) Check S_{12} and S_{21} from:

$$S_{12} = -\left[\alpha_1 S_{11} - (S_{11} - 1)\left(1 + \frac{R_5}{R_3}\right)\right] \quad . (11)$$

$$S_{21} = \frac{S_{22} - 1}{(1 - \alpha_1) + \frac{R_5}{R_3}} \quad \ldots\ldots (12)$$

(*f*) If required, the collector-base potential of the first stage may be checked. This has a maximum value when the first stage is cut off, and is given approximately by:

$$V = \left(\frac{R_3}{R_2 + R_3 + R_5}\right)E \quad \ldots\ldots (13)$$

In most applications the leakage currents I_{co1} and I_{co2} may be taken as zero, resulting in great simplifications to the equations. As in the basic arrangement, a high value for R_4 is preferable. S_{11} and S_{22} should be chosen in the range 1.3 to 3.0.

Example of decoupling

A similar example to the previous one will illustrate the procedure; the data assumed are:

$\alpha_1 = 0.925 \quad I_{c1} = 2$ ma $\quad E = 28$ v

$\alpha_2 = 0.94 \quad I_{c2} = 5$ ma $\quad I_{co1} = I_{co2} \approx 0$

Taking $R_4 = 2{,}200$ ohms again, with $S_{11} = 3$ and $S_{22} = 2$, and following the design steps:

(*a*) $R_1 =$ 6,350 ohms
(*b*) $R_3 =$ 28,000 ohms
(*c*) $R_5 =$ 3,500 ohms
(*d*) $R_2 =$ 88,100 ohms
(*e*) $S_{12} = -0.53 \quad S_{21} = 5.0$
(*f*) V = 6.5 volts.

The S factors are satisfactory. The first stage transistor need have a rating of only about 10 volts. Once again, any of the amplifier configurations may be used with this basic circuit. END

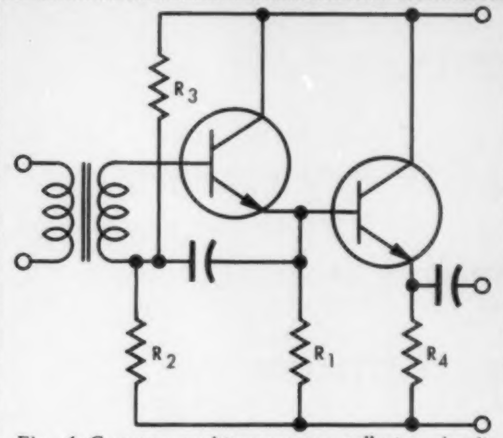


Fig. 4 Common emitter-common collector circuit.

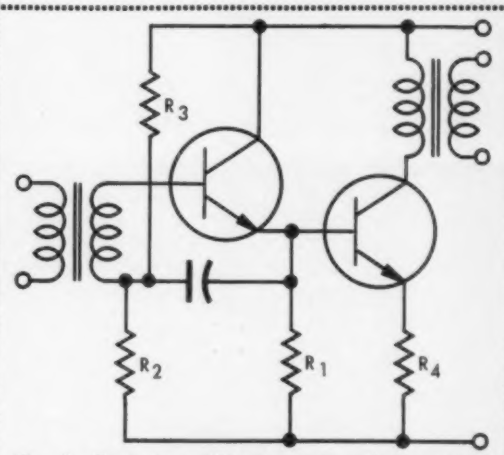


Fig. 5. Common emitter-common emitter arrangement. Again it may be unnecessary to bypass R_4. Output load could also be resistance-capacitance coupled.

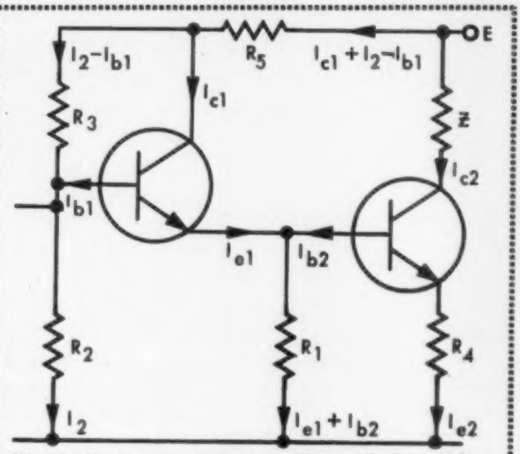


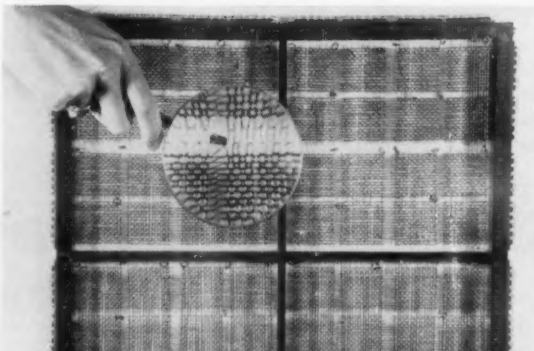
Fig. 6. Basic arrangement of Figure 1, but with a decoupling resistance R_5 added to the first stage

What's new in view

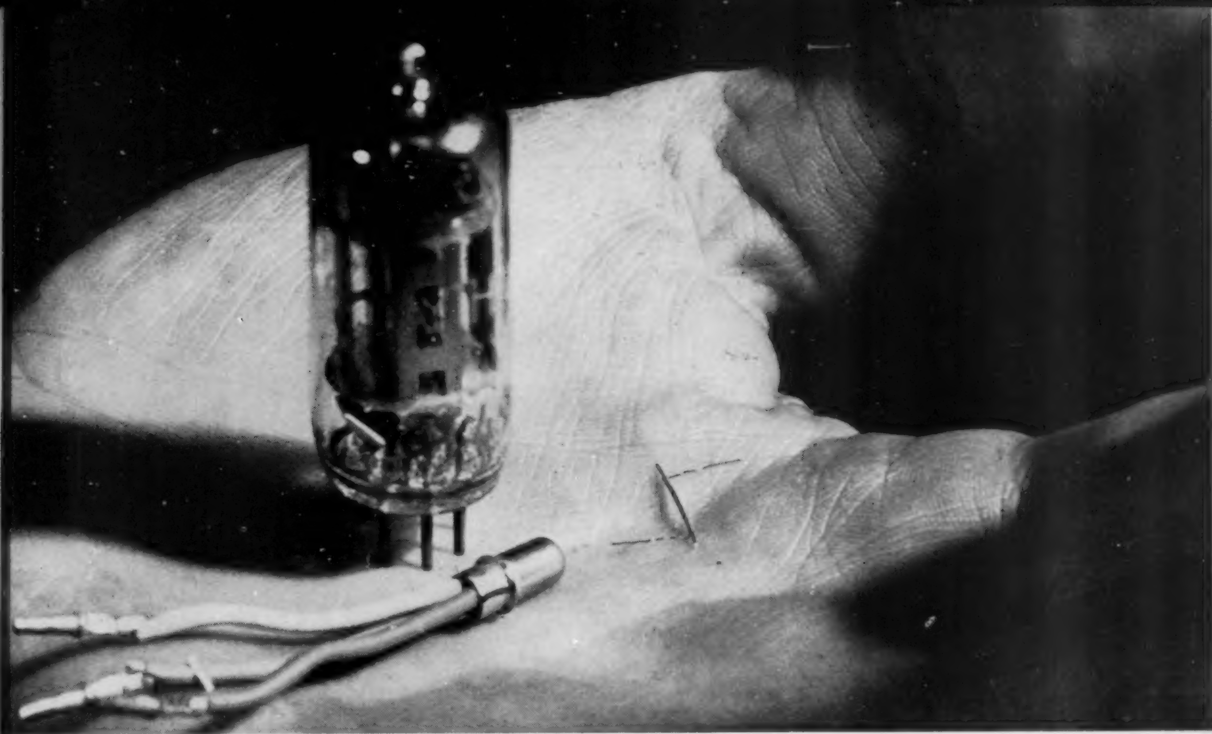
100 cryotrons will go into a thimble

Giant eye of the Telescopic Photographic Recorder is capable of tracking and photographing an object smaller than a baseball at altitudes in excess of 20,000 feet. Recorder, completely mobile, was designed and built by the Perkin-Elmer Corporation

Antennas used by Federal Telecommunication Laboratories, Nutley, N.J. in experimental micro-wave transmission over a distance of 91 miles



The 16,384 cores arranged in this screen-like lattice represent more than 400 hours work. The memory has been made by Computing Devices of Canada Ltd.



PICTURE OF THE MONTH ▲

When cooled to below minus 420 deg. fahrenheit the cryotron, right, can replace the vacuum tube and transistor in some computer applications. Cryotron was developed by Dudley A. Buck at the Massachusetts Institute of Technology. Minute size means 100 can fit into an ordinary thimble

Clusters of silicon wafers in this U. S. Army helmet can collect enough power from the sun to operate minute transceiver

Remote handling of isotopes from behind a lead brick wall at Radio-Chemical Centre, Amersham, U.K. The window is made of lead glass

A new angle on this maze of circles makes a fine photographic pattern. Picture is of the load face of BEPO, Britain's first atomic pile

For your library

Basic approach to problems of solid state physics

An Introduction to Semiconductors
W. Crawford Dunlap, Jr. John Wiley & Sons Inc., New York; 417 pp; $11.75

Dr. Dunlap approaches this work from an almost entirely physical point of view so that even his section on devices emphasizes their mechanisms and mode of operation. The book provides a unified elementary survey of the field, covering basic concepts, properties of materials, methods of measurement and applications.

An indication of the scope of the book is given by some of the chapters: crystals and their structure, theory of the solid state, imperfections in crystals, statistical mechanics for metals and semiconductors, properties of p-n junctions and experimental measurements on semiconductors.

Dr. Dunlap has done extensive research on the properties of silicon, germanium and other semiconductors. He is supervisor in solid state research at the Bendix Aviation Corp. in Southfield, Mich. (638)

A Further Handbook of Industrial Radiology
W. J. Wiltshire, B.A., F.Inst.P., editor. MacMillan Company of Canada Ltd.; 334 pp; $8.50

An earlier "Handbook of industrial radiology" dealt with the fundamentals of the use of radiological methods of testing. Now members of the British Non-Destructive Testing Group of the Institute of Physics — who published the earlier volume under a different title — are dealing with new information that has accumulated over the past few years.

This includes the development of accelerators, which has made possible the production of radiation of high energy and in great intensity; the advent of a supply of radioisotopes with their convenience and adaptability facilitating many applications of radiological methods and advances in the electronic field which have made automatic inspection more practicable in suitable cases.

Each chapter has been written by a specialist in the particular field. They include high voltage x-ray generators, natural and artificial sources for gamma-radiography, scattered radiation, radiographic quality and sensitivity, fluoroscopy, weld radiography, microradiography and industrial xeroradiography. There is also a final chapter which is an introduction to applied x-ray diffraction methods. Although this subject forms no part of industrial radiology in general it is included to help newcomers to radiological testing and is valuable as a brief account of the principles involved and the apparatus used.

This book is regarded as a complement to the earlier Handbook and is not intended to supersede it. (639)

Automation in Business and Industry
Edited by Eugene M. Grabbe. John Wiley & Sons Inc., New York; 611 pp; $10.00

Every new subject is greeted by a degree of confusion, particularly when it bears a name that catches the public fancy as "automation" has. For this reason we welcome any book that can provide a realistic analysis of the subject without prejudice. The authors of Automation in Business and Industry have done their job well, starting with the concept of automation and tracing it through to actual applications and future prospects.

The book has been written for "Business Engineers" and requires a knowledge of mathematics and electronics for complete understanding of all chapters. However, the average businessman will have no trouble following the discussion, particularly in the introductory chapters and those dealing with applications and economics. (640)

Transductors and Magnetic Amplifiers
A. G. Milnes, D.Sc. MacMillan Company of Canada Ltd.; 286 pp; $10.75

The author of this book has been engaged on magnetic amplifier investigations since 1946. He points out that many of the basic circuits have been known for 30 or 40 years, but only with the availability of high performance magnetic cores and rectifiers during the last decade or so has interest in the field become widespread.

There are chapters on introductory theory, construction and elementary circuit technique, magnetic amplifier applications, four-limbed transductors, magnetic core devices and reset transductors which are reasonably free of heavy mathematical treatment. Chapters on series transductor theory and auto-self-excited circuit behaviour make for rather more advanced reading.

The book should be of interest to all designers and users of magnetic amplifiers in industry and to those teaching the subject in advanced electrical courses. There is a selected bibliography of 159 references. (641)

Catalogues and brochures from the manufacturers

Synchros. Data sheet on 400 cps synchros to MIL spec. Muirhead Instruments Ltd., Stratford, Ont. (642)

Precision Optics. Bulletin 0-104 shows production facilities and bulletin 0-105 describes silicon optics for infra-red design. Texas Instruments, Monrovia, Calif. (643)

Tube testing. Sixteen-page technical brochure titled: A positive grid voltage —space current division test for power vacuum tubes. The Ahearn & Soper Co. Ltd., Ottawa. (644)

Tachometers, Generators, Indicators, Recorders. Twelve-page brochure of specifications, illustrations and dimensions. GEC-1258A. Canadian General Electric Co. Ltd. (645)

Eimac quick reference catalog of tubes, rectifiers, vacuum capacitors, etc. 16pp. The Ahearn & Soper Co. Ltd., Ottawa. (646)

Masts and antenna support reference guide. Beatty Bros. Ltd., Fergus, Ont. (647)

Facilities, services, products and history of Measurement Engineering Ltd., Arnprior, Ont. 8pp. (648)

16 mm film titled Airpower 56. Film shows U. S. National Air Show, 1956 and may be had on loan. Aviation Electric Ltd., Montreal (649)

Environmental test chambers—tips and trends. 20pp. Beechy Enterprises, Toronto. (650)

Mass spectrometer leak detector. Bulletin GEC-336B, 12pp. Canadian General Electric Co. Ltd. (651)

Coil winding machine catalogue, 62pp. George Stevens Mfg. Co. Canadian Rep.: A. Andrews, Port Credit, Ont. (652)

Transistor data sheet. NP News, Vol. 1. Texas Instruments Inc., Dallas. (653)

Digital computer elements. Mack Electronics, Boston. (654)

Servo amplifiers, transistorized and hermetically sealed. Bulletin 101. Daystrom Ltd., Toronto. (655)

Type AS miniature molded composition potentiometers. Bulletin 149. Ohmite. (656)

Ceramic Magnets. Bulletin RC-11A with graphs for Ceramagnets. 12 pp. Stackpole Carbon Co. St. Marys' Pa. (657)

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MODELS 101 AND 101-50

Portable Models 101 (100-500 v) and 101-50 (50-250 v)

FEATURES: ★ **Accuracy of ±0.25%**
★ **True rms Reading**
★ **0-1 ma Recorder Connection**
★ **Rugged design to withstand vibration, rough usage**

DESCRIPTION:

Available as either portable or rack-mounted units, these rugged instruments provide true rms readings at an accuracy of ±0.25% of input voltage over a range of 100-500 v in 10 v steps (Model 101), or 50-250 v in 5 v steps (Model 101-50). Large scale divisions reduce reading errors; results may be permanently recorded on a 0-1 ma recorder. Use of a unique thermal bridge circuit provides ± 0.25% accuracy with standard meter movement, eliminating delicate special movements. The result is unusual ruggedness for an instrument of such high accuracy.

APPLICATIONS:

These Expanded Scale Voltmeters are invaluable for all types of testing and development work where high accuracy is a requisite; production quality control of components and circuits, developing new circuits, servicing electronic instruments and systems, measuring voltages in a-c power systems, as a reference instrument in the standards laboratory, and for measurements of line voltage variations in the field. They are adaptable for use in aircraft where vibration might damage more delicate meter movements.

Rack-mounted Models 101-R and 101-R-50

SPECIFICATIONS

	MODEL 101	MODEL 101-50
RANGE:	100 v to 500 v	50 v to 250 v
SCALE RANGE:	12 v	6 v
SMALLEST SCALE DIVISION:	0.2 v	0.1 v
ACCURACY:	±0.25% of Input Voltage	
VOLTAGE INDICATED:	True rms	
FREQUENCY RESPONSE:	50 to 2000 cps	
SOURCE LOADING:	Approximately 2 watts	
METER DAMPING:	0.8 of Critical Damping	
TIME RESPONSE:	0.5 seconds	
RECORDER CONNECTIONS:	0-1 ma dc recorder	
POWER REQUIREMENTS:	115 v ac, 50-2000 cps, 20 watts	
DIMENSIONS: (PORTABLE)	8"W x 9¾"H x 9"D (14 lbs. net)	
DIMENSIONS: (RACK)	19"W x 5¼"H x 9"D (15 lbs. net)	
PRICE: (PORTABLE)	$360.00 f.o.b. factory	
PRICE: (RACK)	$400.00 f.o.b. factory	

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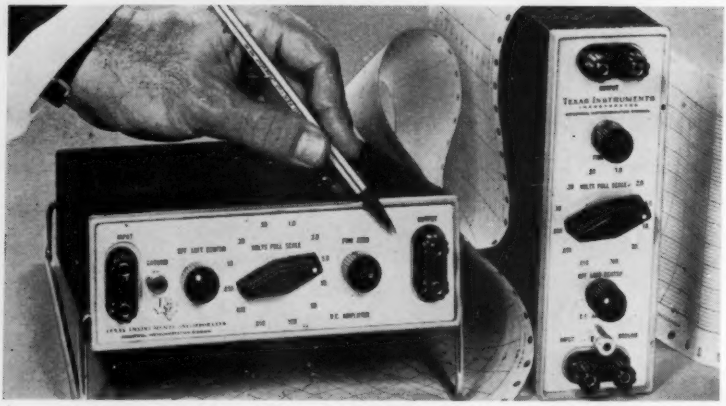
Transistors replace chopper in dc amplifier



Model 301 dc amplifier uses transistors throughout for both modulation and amplification. Sensitivity is 10 millivolts dc to 100 volts dc full scale in 12 ranges, with a frequency response up to 50 cps. Input impedance is 2.5 megohms per volt and output impedance is 39 ohms. The amplifier operates from line voltage or a battery with an operating life of approximately 300 hours.

Texas Instruments Inc., Houston, Texas. (658)

Self-balancing indicator has built-in switches

A self-balancing indicator with built-in key or push button switches is available for (1) thermocouples—with a null balance potentiometer measuring circuit and automatic cold junction compensation; or (2) resistance bulbs—with a null balance AC bridge measuring circuit. Either two or three-position key switches or push button switches may be specified. Key switches accommodate up to 48 points for thermocouples and 36 for resistance bulbs while push buttons accommodate up to 24 points for either. There are 30 available scale ranges covering —400 F to +3000 F for all standard thermocouple calibrations and —100 F to +600 F for resistance bulbs.

Thermo Electric (Canada) Ltd., Brampton, Ont. (659)

Improvements in ceramic type triode

Eimac type 3CX 100A5 ceramic triode is mechanically and electrically interchangeable with the type 2C39 but features these improvements: longer life, 10% more power output at 2,500 mc, full ratings to 60,000 ft., lower inter-electro leakage and sustained performance at elevated temperatures.

The Ahearn & Soper Co. Ltd., Ottawa. (660)

TV has 7 commutated data channels

A final visual check of missile performance immediately prior to firing is now possible with a new 21-inch large screen display developed by Electronic Control Systems, Inc.

The ECS Model C-208 Commutated Data Display provides a visual display of 7 commutated data channels which may contain information from as many as 189 parameters. An example of a data source is the pulse amplitude modulated (PAM) FM/FM telemetering package. It gives a "real time" qualitative picture of the information necessary for a "go-no-go" decision on the readiness of the telemetering system for flight.

Commutated data are automatically synchronized and displayed on as many as 7 separate traces on a 21-inch cathode ray tube, with additional provisions for viewing any portion of any trace on an auxiliary 7-inch cathode ray tube. The equipment is built to MIL Standards, and is capable of trailer installation. Modification giving the same display for PDM can be provided.

Stromberg-Carlson, Rochester. (661)

Servo motor used with transistors

A new high temperature continuous duty servo motor for transistorized operations has been announced by John Oster Manufacturing Company. Type 8-5001-02 measures only .863" L x .750" OD, weighs only 1.2 oz., has an operating temperature range —65°C to +125°C and meets Mil-E-5272. Voltage is 40/20 on control phase and 26 on fixed phase 400 cycle. No load speed is 6500 rpm and stall torque .15 oz.-in. Furnished with synchro mount and pinion type shaft.

John Oster Manuf. Co. Avionic Div., Racine, Wisconsin. (662)

Forty watt X-band magnetron

A 40 watt, X-band pulsed magnetron has been developed for operation in the frequency range from 8800-9600 mcs. The new magnetron is particularly suited for use in airborne radar beacon and navigational systems. The tube is rated at 40 watts peak pulsed power output at a 25 per cent duty cycle for maximum pulse lengths of 5 microseconds. Substantially higher peak powers may be achieved with shorter pulse durations and reduced duty cycle requirements. Frequency and amplitude modulation of the magnetron output pulse has been measured at less than ± 30 kc modulation deviation in experimental models. Operating efficiency of the MA-215 is 20 to 30 per cent. A ceramic cathode bushing structure is used for increased reliability.

The new magnetron weighs approximately 20 ounces.

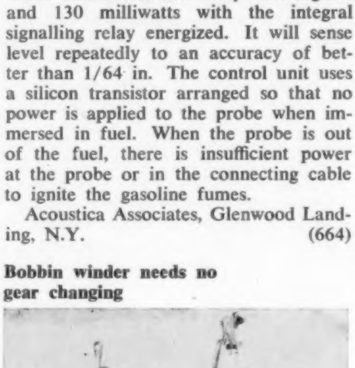
E. G. Lomas Co., Ottawa. (663)

Ultrasonics to check on liquid levels

The model RC-1A liquid level sensor uses ultrasonics to detect the presence or absence of liquid at a predetermined level. The probe measuring approximately 2 in. in length and 11/16 in. outside diameter is mounted vertically in a tank while the associated control unit is mounted external to the tank. Response time of the sensor is less than 10 milliseconds with a total power drain from a 24-29 volt dc source of 15 milliwatts with the control relay de-energized and 130 milliwatts with the integral signalling relay energized. It will sense level repeatedly to an accuracy of better than 1/64 in. The control unit uses a silicon transistor arranged so that no power is applied to the probe when immersed in fuel. When the probe is out of the fuel, there is insufficient power at the probe or in the connecting cable to ignite the gasoline fumes.

Acoustica Associates, Glenwood Landing, N.Y. (664)

Bobbin winder needs no gear changing



This bobbin winder requires no cam or gear changing and has an infinitely adjustable winding traverse between ⅛ in. and 3½ in. Model 412-AM measures 31 in. long x 23 in. wide x 16 in. high and winds all types of random wound bobbin coils and solenoid, relay and repeater coils. A jogging switch permits adding turns at the winding cycles end without resetting counter.

Geo. Stevens, Mfg. Co. Inc., Chicago. (665)

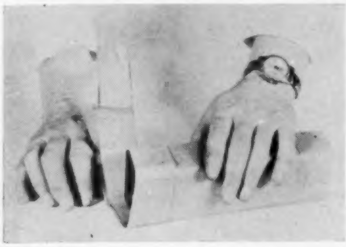
(Continued on page 49)

New Products—cont.

Magnetic shield is foil

To provide magnetic shielding components may now be wrapped in Netic or Co-Netic foil. The material can be cut with ordinary scissors and wrapped around components to provide shielding at both low and high frequencies, at low intensities. Foil is available between 0.003 in. and 0.007 in. thick in rolls up to 14 in. wide and any length desired.

R. S. Griffith, Montreal. (666)



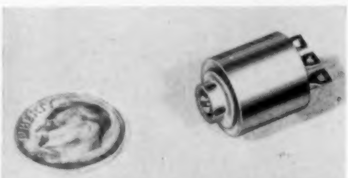
Console for calibrating test instruments

A general-purpose standardization console provides facilities for calibrating ac and dc current and voltage instruments. The self-contained console provides power source, control and circuitry for high accuracy instrument standardization, including the design, development, and service calibration of practically all types of electrical instruments. Regulated power is supplied in the audio frequency range of 50 to 3,000 cps and both ac and dc voltage and current supplies are provided in conventional separate bus facilities up to 150 amps, 750 volts. The console measures 6 ft. long, 4 ft. wide and 5 ft. high.

Canadian General Electric Co., Ltd. (667)

Potentiometer weighs only ten grams

The Mite-E-Mite sub-miniature potentiometer weighs ten grams and measures ½ in. in diameter by ½ in. long. It is



capable of critical temperature applications up to 125 C and is available in resistances up to 75 K ohms. For permanent installations it can be solder-mounted.

San Fernando Mfg. Co., San Fernando, Calif. (668)

(Continued on page 50)

Receivers cover ham and marine bands

Three new "Ham" and general coverage receivers have been added to the National line. The model NC-188 Ham receiver is directly calibrated for the four general coverage ranges and five band spread ranges for the amateur bands (80-10 meters). The receiver also covers 540 kc to 40 mc; voice or CW. Model NC109 shown is a general coverage receiver using a crystal filter and separate product detector for CW and SSB reception. It also includes 4-band coverage (540 kc to 40 mc); and voice, CW or SSB reception. The band spread is calibrated for 10, 11, 15, 20, 40, and 80 meter amateur bands.

Model NC-66 Ham and SWL receiver can be operated on either 115 v ac/dc or a battery; it has five-band coverage from 150 kc to 23 mc, and electrical band spread with logging scale, and a fixed-tune cw oscillator. It includes two built-in antennas (ferrite loop for DF and BC bands and whip for the SW bands).

For boat owners there is a special marine band from 150 kc to 400 kc covering the DF frequencies, and provision for an external direction finder.

Canadian Marconi Co. (669)

Transistorized power supply for mobile units

A transistorized power supply has been designed to provide greater reliability in mobile radio equipment and reduce component replacement cost by eliminating the vibrator. It replaces the receiver portion of the mobile power supply.

Canadian General Electric Co. Ltd. (670)

Iris control for industrial TV systems

An automatic iris and target control unit for industrial and institutional television systems compensates for wide variations in light up to 16,000 to 1 and assures the lowest possible aperture to provide maximum resolution, depth of field and contrast. It eliminates the need for a variable density filter and results in optimum signal to noise ratio.

The iris drive motor automatically corrects the aperture setting to bring the target back within its optimum range if the target voltage moves to one of its limits. Two to five seconds are required for the lens aperture to move between its extreme limits. The new iris and target control unit is designed to be used with any custom system with remote iris operation. It operates from 117 volts ac, 60 cps.

Canadian Westinghouse Co. Ltd. (671)

Versatile photomultiplier photometer

One feature increasing the versatility of the Model PH-200 Universal Photomultiplier Photometer is the ability of this instrument to utilize any photomultiplier or photoelectric tube. Separate zero adjust and dark-current adjust controls, together with both a stepped and a continuously variable sensitivity control are other features. The instrument reads directly densities 0 to 6; percent transmittances 0.0001 to 100. Full scale meter deflection for 10^{-9} amperes tube current. Provision is made for connecting to either an oscilloscope or recorder.

Radionics Ltd., Montreal. (672)

(Continued on page 53)

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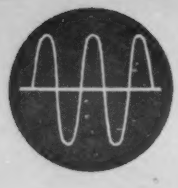

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New products—cont.

Differential dc amplifier

The Model A10 differential dc amplifier provides a means of measuring both in-phase and out-of-phase signals. Input impedance of the amplifier is 100 K ohms. With line regulation, drift is less than ±5 microvolts. Gain steps are provided from 0 to 1,000 with gain accuracy greater than 1% at 2 KC. The open loop gain is 100 db out to 800 cycles and 150 db at dc. The instrument is self-contained and requires input power of 100 watts.

Electrochemical Products, Agincourt, Ont. (673)

Tape recorder runs at 1⅞ i.p.s.

The Tandberg tape recorders Model 3 and 3F have three tape speeds fast, forward and rewind, five-watt amplifier, 5 in. x 7 in. Goodman speaker and leather carrying case. Frequency response is rated at ± 2 db, 50 cps to 4,000 cps at 1⅞; ± 2 db, 50 cps to 8,000 cps at 3¾ ips; ± 2 db, 30 cps to 16 kc at 7½ ips. Frequency response of amplifier is ±2 db, 40 cps to 20 kc. Input power is 55w, 115 v, 60 cps.

Engineered Sound Systems, Toronto. (674)

Balanced mixers for waveguide systems

A series of millimeter wave balanced mixers has been developed for use with RG-96/U waveguide transmission systems. When used with matched pairs of 1N53 or 1N53A coaxial mixer crystals, the MA-1026 series provides local oscillator noise suppression in K-band radar receivers over the 34-36 kmc range. VSWR is 1.3 max., balance is ½ db, cross talk is 20 db (min), and output capacity is 3 uuf (nominal).

E. G. Lomas Co., Ottawa. (675)

(Continued on page 54)

Pressure transducer will operate over wide temperature range

A pressure transducer that operates continuously in temperatures from —65°F. to +300°F. with less than 1.0% deviation is now in production at Edcliff Instruments. This transducer also can be ordered for operation up to +400°F. Model 2-8-2 withstands vibrations of ±25g on all axes, and overpressure of up to 50% causes no shift in calibration. It is available in pressures ranging up to 10,000 psi absolute, gauge, or differential, with an over-all error of less than ±1.0%.

Gauge and absolute units of this potentiometer-type instrument can be used in systems involving corrosive fluids or gases.

Endcliff Instruments, Monrovia, Calif. (676)

Capacitors give heavy-duty welding power

A heavy-duty precision welding power supply makes available a maximum 250 watt-seconds of heat energy, continuously controllable from one watt-second. The Weldmatic Model 1027 contains a bank of heavy duty capacitors which total 3,200 microfarads, mounted in an interlocked pull-out drawer in a ventilated steel cabinet. Discharged time varies from 0.002 to 0.0025 seconds with the welding transformer in parallel, and from 0.008 to 0.010 seconds with the transformer in series. The transformer is part of the welding head and is separated from the power supply in order to minimize energy losses. Input power is 110 v, 60 cps.

Weldmatic Division, Unitek Corporation, Pasadena, Calif. (677)

Crystal microphone has wide response range

Crystal microphone model M332 is designed for both hand and lavalier use. Frequency response is rated at 30 to 15,000 cps with an output level of —57 db. It is a slim-line design with a pressure cast housing finished in satin chrome. Manufacturers models are available in satin black or color bodies with chrome trim. Model M-322-S also includes a built-in on-off switch.

Astatic Corporation, Conneaut, O.

(Continued on page 56)

New products—cont.

Impedance bridge

The ESI Model 291 Universal impedance bridge contains a dc generator for measuring resistance and conductance. It also has an adjustable 0 to 15-volt power supply (100 cps to 10 kc) for ac impedance measurements. Bridge nulls are detected on a light beam type galvanometer.

The operating ranges are: 0.1 milliohms to 1.2 megohms ±0.1%, 0.1 uu mhos to 1.2 mhos ±0.1%, 0.1 uuf to 1,200 uf ±0.2%, 0.1 uh to 1,200 h ±0.3%.

MEL Sales, Arnprior, Ont. (679)

Handles both magnetic and photographic sound

A 16-mm television projector has both magnetic and photographic sound facilities to handle either single system transmission or double system transmission in conjunction with a magnetic sound reproducer. A lever selects either magnetic or photographic sound.

The single system transmission uses either the photographic sound or the magnetic sound track which is on the same film as the picture. In double system transmission the sound track is on a separate, full-width, magnetic coated film.

Pye Canada Ltd., Toronto. (680)

Converter compares ratio of two signals

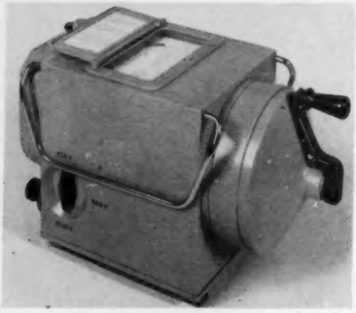
Electro Instruments ac converter ac signals to dc voltages allowing automatic measurement of the ratio of 2 ac signals. The "direct" percent" measurement is displayed digitally on 1-in. high, edge-lighted numerals contained on the face panel of the switch module. Accuracy is rated at ± 2 digits and linearity with the amplifier is 0.01%. A 10% overscale readout is provided for deviation readout in percent.

Electromechancial Products. (681)

(Continued on page 58)

New products—continued

Megger insulation testers have three voltage ranges



Two new Megger insulation testers are now available, each providing three testing voltages. Model 54029 generates 1,000, 500 and 250 volts with a resistance range of 0-200 megohms. Model 54038 delivers 500, 250 and 100 volts, resistance range 0-100 megohms. Both have constant-pressure generators and the scale range remains the same for each of the three testing pressures selected.

R. H. Nichols Ltd., Toronto. (682)

Switch does not alter volume settings

This pull-push switch permits radio, TV and other electronic equipment to be switched on with a pull and off with a push without altering volume setting. The SPST switch is rated at 3 amp, 125 v and is available with either printed circuit or standard solderlike type terminals. The switch can be used with any CTS 15/16 in. diameter bushing mounted single section or concentric tandem control.

C. C. Meredith & Co. Ltd., Streetsville, Ont. (683)

Antenna will mount on side of towers

For the 25-50 mc communications band the Andrew Corp. has developed a side mount antenna that can be mounted directly to structural members of towers where the top of the tower is being used for other equipment. The basic unit is a centre fed, half-wave folded tipole with 3-point mounting system. The average gain over a conventional dipole is 2.5 db and the coverage pattern is on the directional except on large towers which may cause some pattern distortion.

Andrew Antenna Corp., Ltd., Whitby, Ont. (684)

Devices cuts down initial power surge to sets

By reducing the starting heater voltage to about 60% of normal for 10 seconds, tube life may be more than tripled according to the manufacturer of the "Tube Saver." The ac power plug of the TV set, radio, instrument, etc., is plugged into the socket of the "Tube Saver" which in turn is plugged into the wall outlet. When the appliance is turned on current passes through a surge limiting resistor for approximately 10 seconds until a bi-metal strip closes bypass contacts to cut out the resistor.

Mourlife, Trenton, Ont. (685)

Glow counter tubes on new models

The Dynapar Corp. have announced their type 514 preset counter using glow counter tubes. The instrument is available with 2, 3, 4, 5 and 6 digits, and is provided with plug-in units for easy servicing. The count range varies from one to 99 up to one to 999,999 depending on model and the sensitivity is 50 mv to 100 volts rms.

Electrodesign, Montreal. (686)

Insulated flexible lead wire

Available now is Teflon insulated flexible lead wire with its surface treated to provide adequate adhesion with impregnated and casting materials. The manufacturers claims that the treated Teflon wire exhibits the same thermo and electrical characteristics as conventional Teflon insulated conductors.

Hitemp Wires, Inc., Long Island, N.Y. (687)

Advertisers' Index

Round-up: news and future events

Over six hundred of the world's leading crystallographers took part in the Union of Crystallographers' Fourth General Assembly and International Congress held at McGill University, Montreal. In the picture are, left to right: E. Batler (Manager, Professional Products Division, Philips Industries Ltd.), Dr. Bernal and Dorothy Crawford Hodgin (U.K.), B. K. Vainstein (U.S.S.R.), Dr. William Parrish (Director of Crystallography Research, Philips, U. S.)

With this issue Electronics Engineering of Canada becomes Canadian Electronics Engineering, a name which will identify us more closely with the industry we serve. There is no other change in style or format.

IMAGES CAN BE REPRODUCED ON FLAT PANELS

A group of three devices which produce images electronically on flat panels has been developed by Sylvania Electric Products Inc. under the name of "Sylvatron."

The panels are electroluminescent glass or metal squares controlled by a photo-conducting element which enables them not only to produce light but to produce images. The three basic types at the moment are:

1. An electroluminescent panel on which the position of a mobile dot of light can be manipulated electrically.

2. A display panel which reproduces optically the track of a mobile spot of light. The image thus created can then be held or stored indefinitely in visible form on the panel.

3. An electroluminescent panel which can reproduce optically a motion picture with good resolution and rapid response.

A combination of 1 and 2 could convert electrical data into pips of light, or a track of light, and store this resulting light combination which could be visually reproduced as numbers, letters or pictures.

A combination of 1 and 3 would electronically, as opposed to optically, reproduce motion pictures.

So far the devices have been produced in two and four-inch squares. Various colors can be utilized. Present colors have been chiefly blue and green.

FOR YOUR DIARY

3-14 International Union of Geodesy & Geophysics, eleventh general assembly, University of Toronto.
4-6 Magnetic Amplifiers Conference, Pittsburgh.
8-21 Atomic Energy Course for Management, Knokke, Belgium.
11-23 Radio, TV & Electronics exhibition, Paris.
24-25 Industrial Electronics Conference, Chicago.

October

7-9 National Electronics Conference, Chicago.
7-11 AIEE Fall General Meeting, Chicago.
9-11 CEMA Annual Convention, Niagara Falls, Ont.
16-18 IRE Canadian Convention & Exposition, Toronto.
21-26 International Conference on Ultra High Frequency Circuits and Antennas, Paris.
28-30 East Coast Aeronautical and Navigational Conference, Baltimore.
30-Nov. 2 Toronto High-Fidelity Exposition, Park Plaza Hotel, Toronto.

November

6-8 Third Annual Symposium on Aeronautical Communications, Utica, N.Y.
13-14 Mid-America Electronics Conference, Kansas City.

December

3-4 Professional Group on Vehicular Communications, Annual Meeting, Washington, D.C.

Special issue for IRE Convention

With October comes the IRE Canadian Convention and Exposition in Toronto. Canadian Electronics Engineering is preparing an important pre-show issue which will give readers all the information they want about every aspect of the convention.

This special issue will include:

Messages from leading personalities in the IRE and electronics industry.

Full list of exhibitors, booth numbers, personnel and details of their products.

Time table of technical papers with summaries of each paper.

Maps of the layout of the exhibition floor.

List of events, officials and other general information.

There will also be articles and department news in this outstanding October issue.

Hi-fi experts will lecture in Toronto

Several authorities on high fidelity will be in Toronto at the end of October to speak at the third annual Toronto High Fidelity Exposition being held at the Park Plaza hotel from October 30 to November 2.

They include Emery Cook, of Cook records fame, R. W. Merrick of the British Ferrograph Recorder Company and Harold Leak, the British amplifier manufacturer.

The exposition is sponsored by a group of high fidelity manufacturers and sales representatives who have formed a Canadian organization known as the Dominion High Fidelity Association. President of the Association is R. C. Kahnert.

There will be three large function rooms, five suites and forty single rooms available for the exposition. Show manager is John T. Rochford, who is also national secretary-treasurer of the CEWA.

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